Guide to the Geology of the Lake Shelbyville Area, Shelby and Moultrie Counties, Illinois

W.T. Frankie, A.C. Phillips, R.J. Jacobson, and M.M. Killey
Illinois State Geological Survey

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Field Trip Guidebook 1998C
September 19, 1998

Department of Natural Resources
ILLINOIS STATE GEOLOGICAL SURVEY

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Cover photo *Findlay Bridge, Lake Shelbyville Dam, and white-tail deer at Wolf Creek State Park. (photos by W. Frankie).*

Geological Science Field Trips The Geoscience Education and Outreach Unit of the Illinois State Geological Survey (ISGS) conducts four free tours each year to acquaint the public with the rocks, mineral resources, and landscapes of various regions of the state and the geological processes that have formed them. Each trip is an all-day excursion through one or more Illinois counties. Frequent stops are made to explore interesting phenomena, explain the processes that shape our environment, discuss principles of earth science, and collect rocks and fossils. People of all ages and interests are welcome. The trips are especially helpful to teachers who prepare earth science units. Grade school students are welcome, but each must be accompanied by a parent or guardian. High school science classes should be supervised by at least one adult for each ten students.

A list of guidebooks of earlier field trips useful for planning class tours and private outings can be obtained by contacting the Geoscience Education and Outreach Unit, Illinois State Geological Survey, Natural Resources Building, 615 East Peabody Drive, Champaign, IL 61820-6964. Telephone: (217) 244-2427 or 333-4747.

Five USGS 7.5-Minute Quadrangle maps (Fancher, Kirksville, Middlesworth, Shelbyville, and Sullivan) provide coverage for this field trip area.

ILLINOIS
DEPARTMENT OF NATURAL RESOURCES

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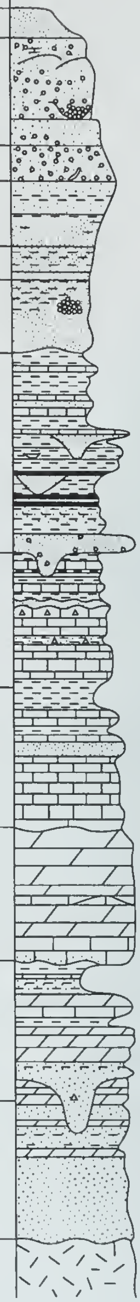
Era		Period or System and Thickness	Epoch	Age (years ago)	General Types of Rocks
CENOZOIC "Recent Life"	Age of Mammals	Quaternary 0-500'	Holocene	10,000	Recent– alluvium in river valleys
			Pleistocene Glacial Age	1.6 m	Glacial till, glacial outwash, gravel, sand, silt, lake deposits of clay and silt, loess and sand dunes; covers nearly all of state except northwest corner and southern tip
		Tertiary 0-500'	Pliocene	5.3 m – 36.6 m	Chert gravel, present in northern, southern and western Illinois
			Eocene	57.8 m	Mostly micaceous sand with some silt and clay; presently only in southern Illinois
			Paleocene	66.4 m	Mostly clay, little sand; present only in southern Illinois
MESOZOIC "Middle Life"	Age of Reptiles	Cretaceous 0-300'		144 m – 286 m	Mostly sand, some thin beds of clay, and, locally, gravel, present only in southern Illinois
PALEOZOIC "Ancient Life"	Age of Amphibians and Early Plants	Pennsylvanian 0-3,000' ("Coal Measures")		320 m	Largely shale and sandstone with beds of coal, limestone, and clay
		Mississippian 0-3,500'		360 m	Black and gray shale at base, middle zone of thick limestone that grades to siltstone chert, and shale; upper zone of interbedded sandstone, shale, and limestone
	Age of Fishes	Devonian 0-1,500'		408 m	Thick limestone, minor sandstones and shales; largely chert and cherty limestone in southern Illinois; black shale at top
	Age of Invertebrates	Silurian 0-1,000'		438 m	Principally dolomite and limestone
		Ordovician 500-2,000'		505 m	Largely dolomite and limestone but contains sandstone, shale, and siltstone formations
		Cambrian 1,500-3,000'		570 m	Chiefly sandstones with some dolomite and shale; exposed only in small areas in north-central Illinois
		Precambrian			Igneous and metamorhpic rocks; known in Illinois only from deep wells



Generalized geologic column showing succession of rocks in Illinois.

LAKE SHELBYVILLE AREA

The Lake Shelbyville area geological science field trip will acquaint you with the *geology**, landscape, and mineral resources for parts of Shelby and Moultrie Counties, Illinois. The starting point for the field trip is the boat dock at Eagle Creek State Park. Lake Shelbyville is approximately 210 miles south of Chicago, 60 miles southeast of Springfield, 110 miles northeast of East St. Louis, and 190 miles north of Cairo.

If there were one word to describe the area surrounding Lake Shelbyville, it would be "recreation." Some of the more popular recreational activities include camping, fishing, boating, hiking, hunting, golfing, and just plain observing nature.

The Lake Shelbyville recreation area consists of 34,000 acres of land and water. The lake was built by the U.S. Army Corps of Engineers as part of a general comprehensive plan for the development of the Kaskaskia Basin for flood control, recreation, water supply, and fish and wildlife conservation. The normal pool elevation of Lake Shelbyville is 599.7 feet above sea level, and at that elevation the lake encompasses 11,100 surface acres of water. The lake has an average depth of 16 feet and a maximum depth of 67 feet. Islands, coves, peninsulas, and inlets create 250 miles of forested shoreline. Management of land at Lake Shelbyville is shared between the U.S. Army Corps of Engineers and the Illinois Department of Natural Resources. The U.S. Army Corps of Engineers operates Coon Creek, Dam East and West, Forest W. "Bo" Wood, Lithia Springs, Lone Point, Okaw Bluff, Opossum Creek, Spillway, Sullivan Beach, Whitley Creek, and Wilborn Creek recreational areas. In addition, the Corps operates the Camp Camfield Environmental Study Area. The Illinois Department of Natural Resources operates Eagle Creek and Wolf Creek State Parks, and the West Okaw and Kaskaskia Fish and Wildlife Units.

GEOLOGIC FRAMEWORK

Precambrian Era Through several billion years of geologic time, the area encompassing Shelby County has undergone many changes (see generalized geologic column, facing page). The oldest rocks beneath the field trip area belong to the ancient Precambrian *basement complex*. We know relatively little about these rocks from direct observations because they are not exposed at the surface anywhere in Illinois. Only about 35 drill holes have reached deep enough for geologists to collect samples from the Precambrian rocks of Illinois. From these samples, however, we know that these ancient rocks consist mostly of granitic and rhyolitic *igneous*, and possibly *metamorphic*, crystalline rocks formed about 1.5 to 1 billion years ago. From about 1 billion to about 0.6 billion years ago, these Precambrian rocks were exposed at the Earth's surface. During this long period, the rocks were deeply weathered and eroded, and formed a landscape that was probably quite similar to that of the present Missouri Ozarks. We have no rock record in Illinois for the long interval of *weathering* and erosion that lasted from the time the Precambrian rocks were formed until the first Cambrian-age *sediments* accumulated, but that interval is almost as long as the time from the beginning of the Cambrian Period to the present.

Because geologists cannot see the Precambrian basement rocks in Illinois except as cuttings and cores from boreholes, they must use various other techniques, such as measurements of Earth's gravitational and magnetic fields, and seismic exploration, to map out the regional characteristics of the basement complex. The evidence indicates that in southernmost Illinois, near what is now the

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*Words in italics are defined in the glossary at the back of the guidebook. Also please note: although all present localities have only recently appeared within the geologic time frame, we use the present names of places and geologic features because they provide clear reference points for describing the ancient landscape.

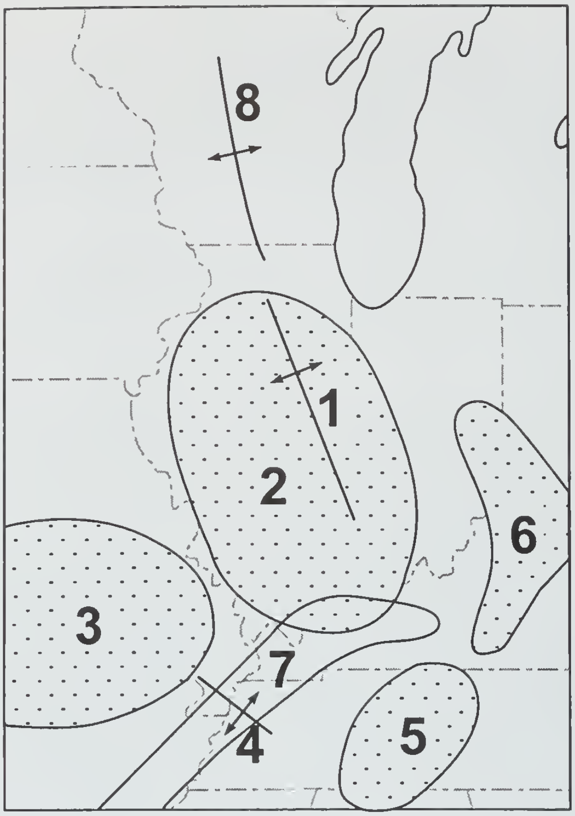


Figure 1 Location of some of the major structures in the Illinois region. (1) La Salle Anticlinorium, (2) Illinois Basin, (3) Ozark Dome, (4) Pascola Arch, (5) Nashville Dome, (6) Cincinnati Arch, (7) Rough Creek Graben–Reelfoot Rift, and (8) Wisconsin Arch.

historic Kentucky–Illinois Fluorspar Mining District, *rift* valleys like those in east Africa formed as the movements of crustal plates (plate *tectonics*) began to rip apart the Precambrian North American continent. These rift valleys in the midcontinent region are referred to as the Rough Creek Graben and the Reelfoot Rift (fig. 1).

Paleozoic Era After the beginning of the Paleozoic Era, about 520 million years ago in the late Cambrian Period, the rifting stopped and the hilly Precambrian landscape began to sink slowly on a broad regional scale, allowing the invasion of a shallow sea from the south and southwest. During the 280 million years of the Paleozoic Era, the area that is now called the Illinois Basin continued to accumulate sediments deposited in the shallow seas that repeatedly covered it. The region continued to sink until at least 15,000 feet of sedimentary strata were deposited. At various times during this era, the seas withdrew and the deposits were weathered and eroded. As a result, there are some gaps in the sedimentary record in Illinois.

In the field trip area, *bedrock* strata range in age from more than 520 million years (the Cambrian *Period*) to less than 320 million years old (the Pennsylvanian Period). Figure 2 shows the succession of Paleozoic rock strata a drill bit would penetrate in this area if the rock record were complete and all the *formations* were present.

The elevation of the top of the Precambrian basement rocks within the field trip area ranges from 7,000 feet below sea level in northwestern Shelby County to 9,000 feet below sea level in southeastern Shelby County. The thickness of the Paleozoic sedimentary strata deposited on top of the Precambrian basement ranges from about 7,500 feet in northwestern Shelby County to about 9,600 feet in southeastern Shelby County.

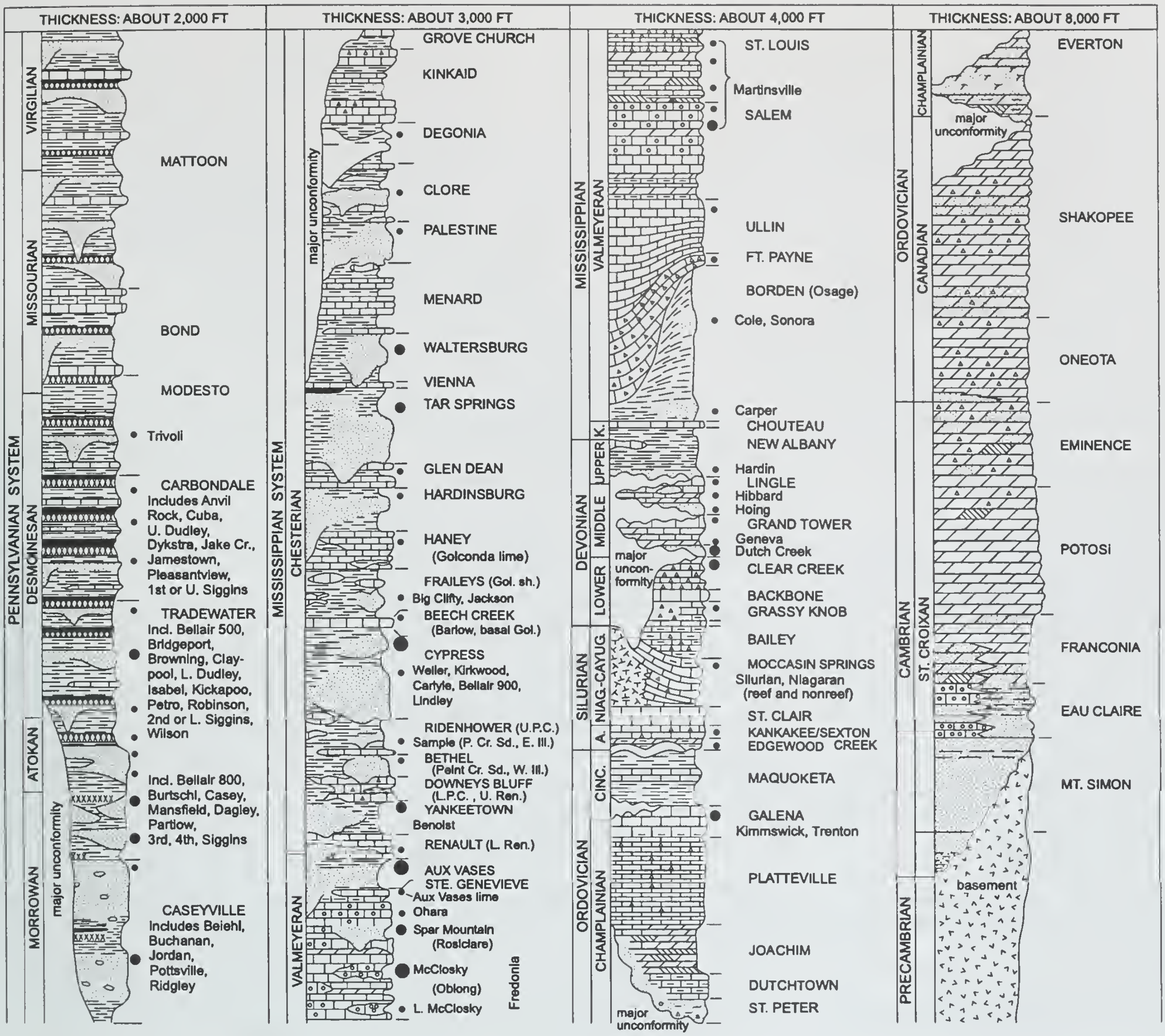


Figure 2 Generalized stratigraphic column of the Paleozoic rocks in the field trip area. Black dots indicate oil and gas pay zones. Unconformities are indicated by wavy lines.

STRUCTURAL AND DEPOSITIONAL HISTORY

As noted previously, the Rough Creek Graben and the Reelfoot Rift (figs. 1 and 3) were formed by tectonic activity that began in the latter part of the Precambrian Era and continued until the Late Cambrian. Toward the end of the Cambrian, rifting ended and the whole region began to subside, allowing shallow seas to cover the land.

Paleozoic Era From the Late Cambrian to the end of the Paleozoic Era, sediments continued to accumulate in the shallow seas that repeatedly covered Illinois and adjacent states. These inland seas connected with the open ocean to the south during much of the Paleozoic, and the area that is now southern Illinois was like an embayment. The southern part of Illinois and adjacent parts of Indiana and Kentucky sank more rapidly than the areas to the north, allowing a greater thickness of sediment to accumulate. During the Paleozoic and Mesozoic Eras, the Earth's thin crust was periodically flexed

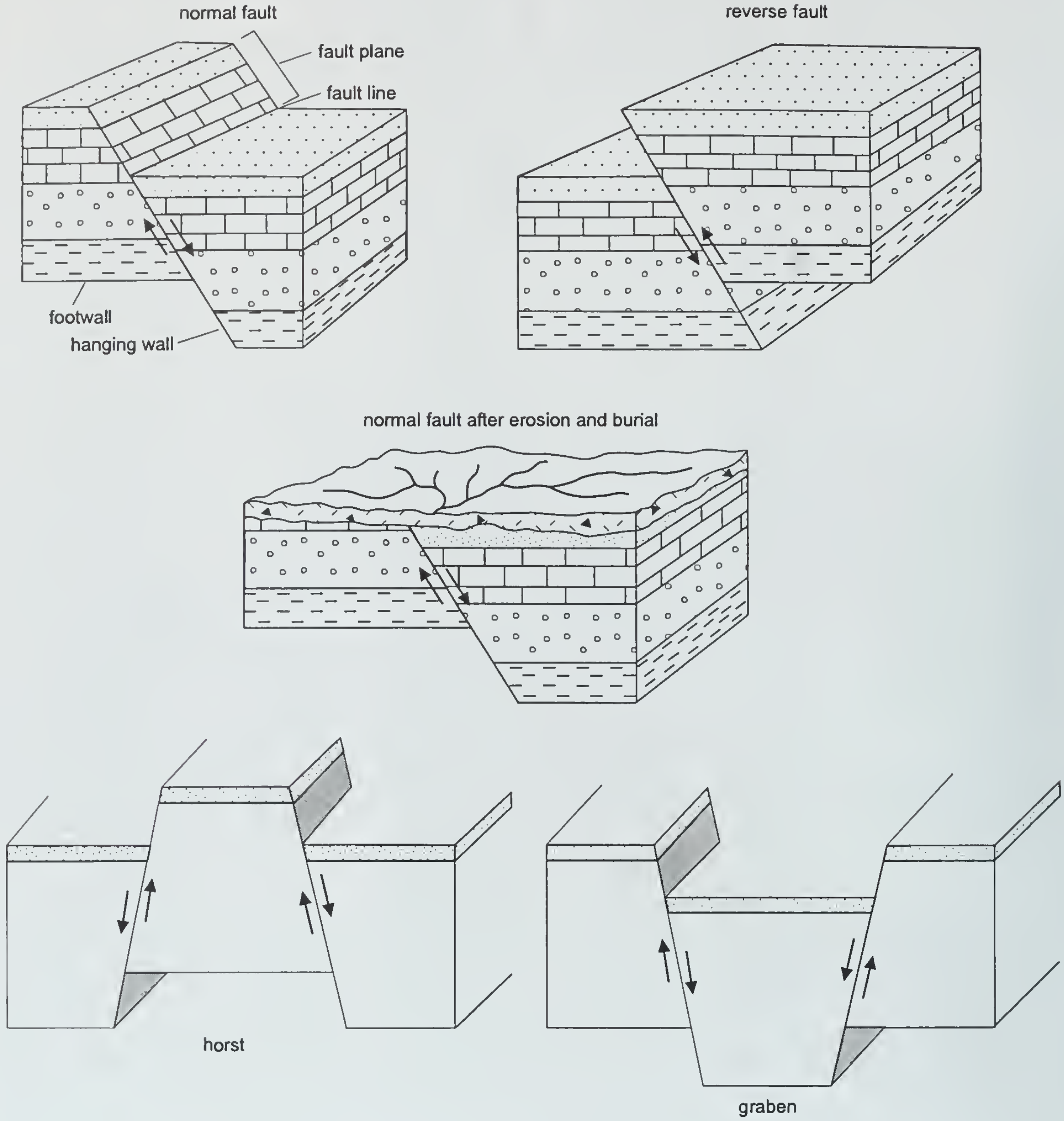


Figure 3 Diagrammatic illustrations of fault types that may be present in the field trip area (arrows indicate relative directions of movement on each side of the fault).

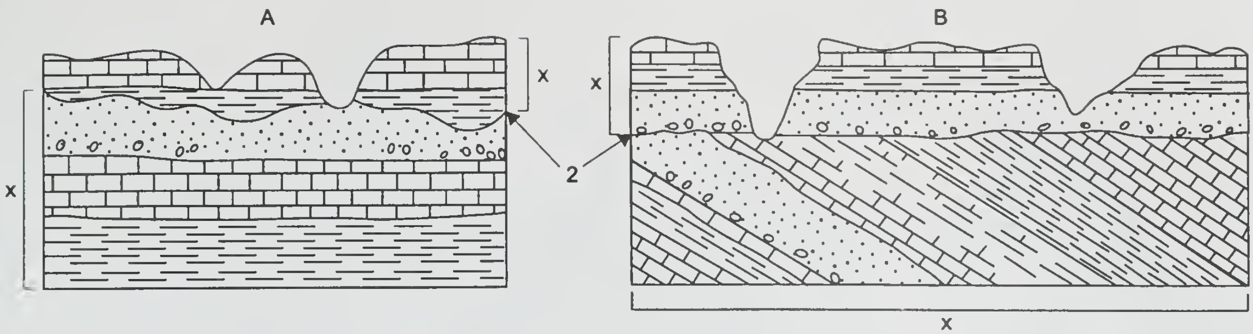


Figure 4 Schematic drawings of (A) a disconformity and (B) an angular unconformity (x represents the conformable rock sequence and z is the plane of unconformity).

and warped in places as stresses built up in response to tectonic forces (plate movement and mountain building). These movements caused repeated invasions and withdrawals of the seas across the region. The former sea floors were thus periodically exposed to erosion, which removed some sediments from the rock record.

Many of the sedimentary units, called *formations*, have *conformable* contacts—that is, no significant interruption in deposition occurred as one formation was succeeded by another (figs. 2 and 4). In some instances, even though the composition and appearance of the rocks change significantly at the contact between two formations, the *fossils* in the rocks and the relationships between the rocks at the contact indicate that deposition was virtually continuous. In contrast however, in some places, the top of the lower formation was at least partially eroded before deposition of the next formation began. In these instances, fossils and other evidence in the two formations indicate that there is a significant age difference between the lower unit and the overlying unit. This type of contact is called an *unconformity* (fig. 4). If the *beds* above and below an unconformity are parallel, the unconformity is called a *disconformity*. However, if the lower beds were tilted and eroded prior to deposition of overlying beds, the contact is called an angular unconformity.

Unconformities occur throughout the Paleozoic rock record and are shown in the generalized stratigraphic column (fig. 2) as wavy lines. Each unconformity represents an extended interval of time for which there is no rock record in this area.

Near the close of the Mississippian Period, gentle arching of the rocks in eastern Illinois initiated the development of the La Salle Anticlinorium (figs. 1 and 5). This is a complex structure having smaller structures such as domes, anticlines, and synclines superimposed on the broad upwarp of the anticlinorium. Further gradual arching continued through the Pennsylvanian Period. Because the youngest Pennsylvanian strata are absent from the area of the anticlinorium (either because they were not deposited or because they were later eroded away), we cannot determine just when folding ceased—perhaps by the end of the Pennsylvanian or during the Permian Period a little later, near the close of the Paleozoic Era.

Mesozoic Era During the Mesozoic Era, the rise of the Pascola Arch (figs. 1 and 5) in southeastern Missouri and western Tennessee produced a structural barrier that helped form the current shape of the Illinois Basin by closing off the embayment and separating it from the open sea to the south. The Illinois Basin is a broad, subsided region covering much of Illinois, southwestern Indiana, and western Kentucky (fig. 1). Development of the Pascola Arch, in conjunction with the earlier sinking of the deeper portion of the basin to the north, gave the basin its present asymmetrical, spoon-shaped configuration (fig. 6). The tectonic uplifting of the Pascola Arch is responsible for the regional

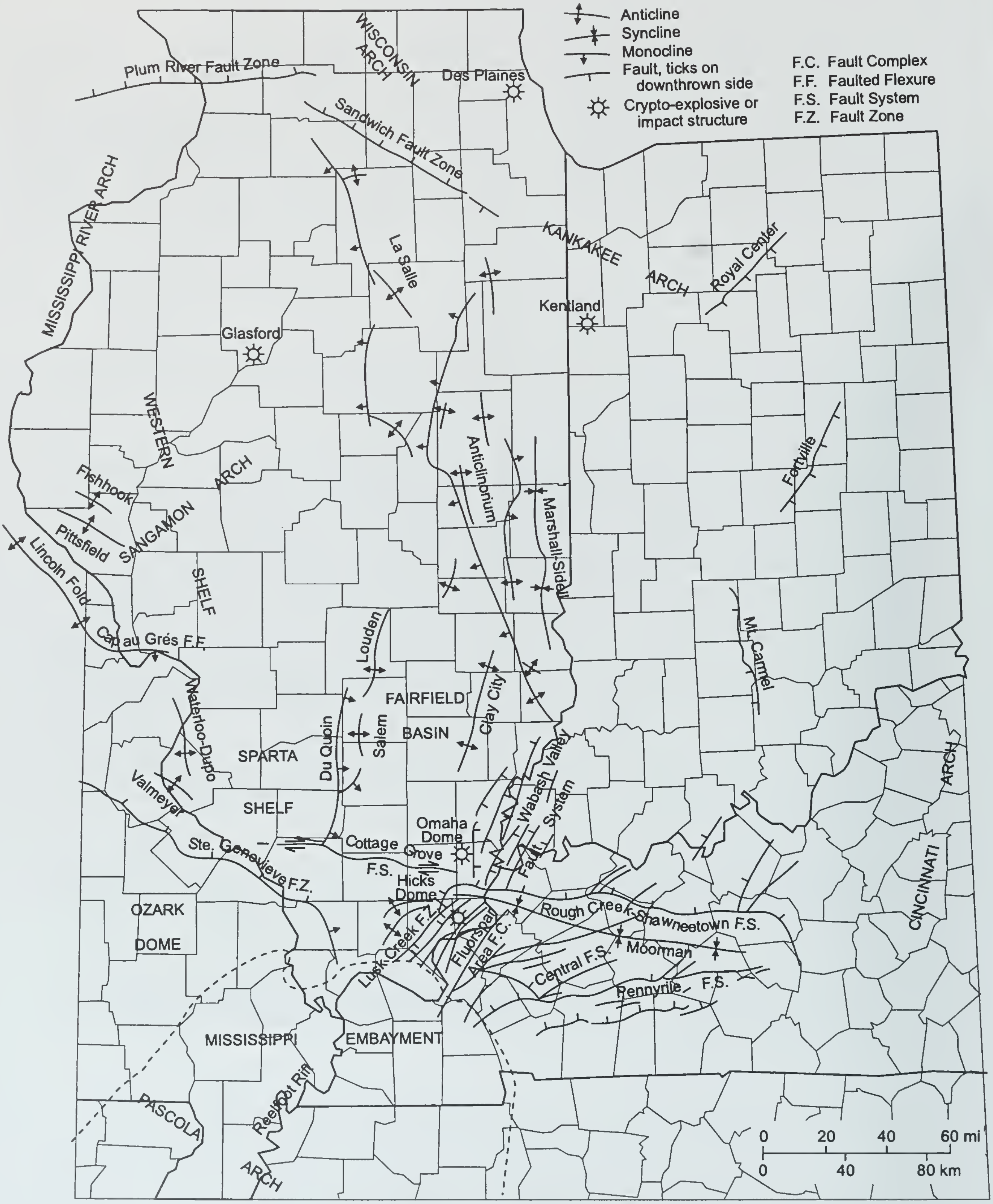


Figure 5 Structural features of Illinois (modified from Buschbach and Kolata 1991).

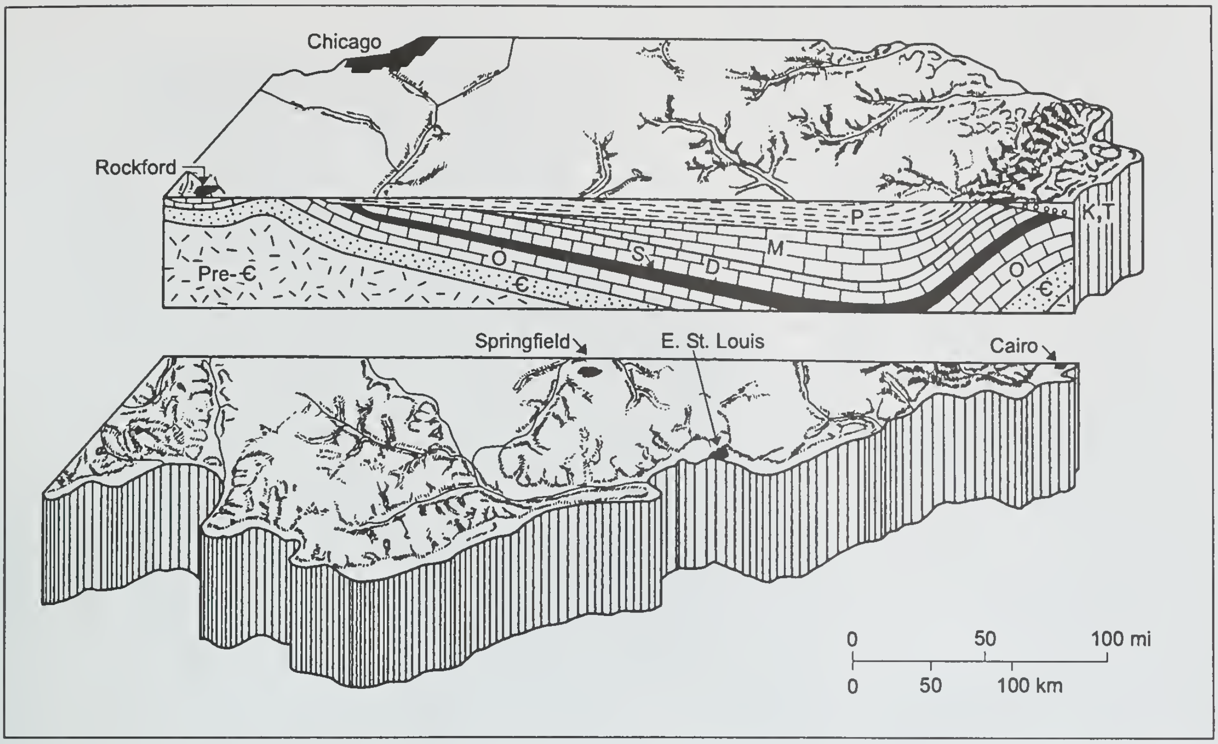


Figure 6 Stylized north–south cross section shows the structure of the Illinois Basin. To show detail, the thickness of the sedimentary rocks has been greatly exaggerated and younger, unconsolidated surface deposits have been eliminated. The oldest rocks are Precambrian (Pre-Є) granites. They form a depression filled with layers of sedimentary rocks of various ages: Cambrian (Є), Ordovician (O), Silurian (S), Devonian (D), Mississippian (M), Pennsylvanian (P), Cretaceous (K), and Tertiary (T). Scale is approximate.

northward dipping nature of the Paleozoic rocks along the southern portion of the Illinois basin (see figs. 5 and 6). This uplifting of the Paleozoic rocks and subsequent erosion created the east–west escarpment of Mississippian- and Pennsylvanian-aged strata in southern Illinois. This escarpment forms the southern edge of the Illinois Basin. South of this escarpment, the deeply eroded Paleozoic rocks are overlain by Cretaceous- and Tertiary-aged sediments (fig. 6), which were deposited in an area called the Mississippi Embayment (fig. 5). The geologic map (fig. 7) shows the distribution of the rock *systems* of the various geologic time periods as they would appear if all the glacial, windblown, and surface materials were removed.

Younger rocks of the latest Pennsylvanian Period, and perhaps the Permian (the youngest rock systems of the Paleozoic), may at one time have covered the Pennsylvania strata that are exposed in the southern part of the field trip area. There is a possibility that even younger rocks from the Mesozoic and Cenozoic Eras, which are deposited south of the Mississippian Escarpment (see fig. 7 and generalized geologic column), may have been deposited here. Indirect evidence, based on the stage of development (rank) of coal deposits and the generation and maturation of petroleum from source rocks (Damberger 1971), indicates that perhaps as much as 1.5 miles of additional sedimentary rocks of latest Pennsylvanian age and younger once covered southern Illinois. During the more than 240 million years since the end of the Paleozoic Era (and before the onset of *glaciation* 1 to 2 million years ago), however, several thousands of feet of strata may have been eroded. Nearly all traces of any post-Pennsylvanian bedrock that may have been present in Illinois north of the Mississippian Embayment were removed. During this extended period of erosion, deep valleys were carved into the gently tilted bedrock formations. These valleys are referred to as bedrock valleys (fig. 8). Later, the topographic *relief* was reduced by repeated advances and melting back of continental *glaciers*

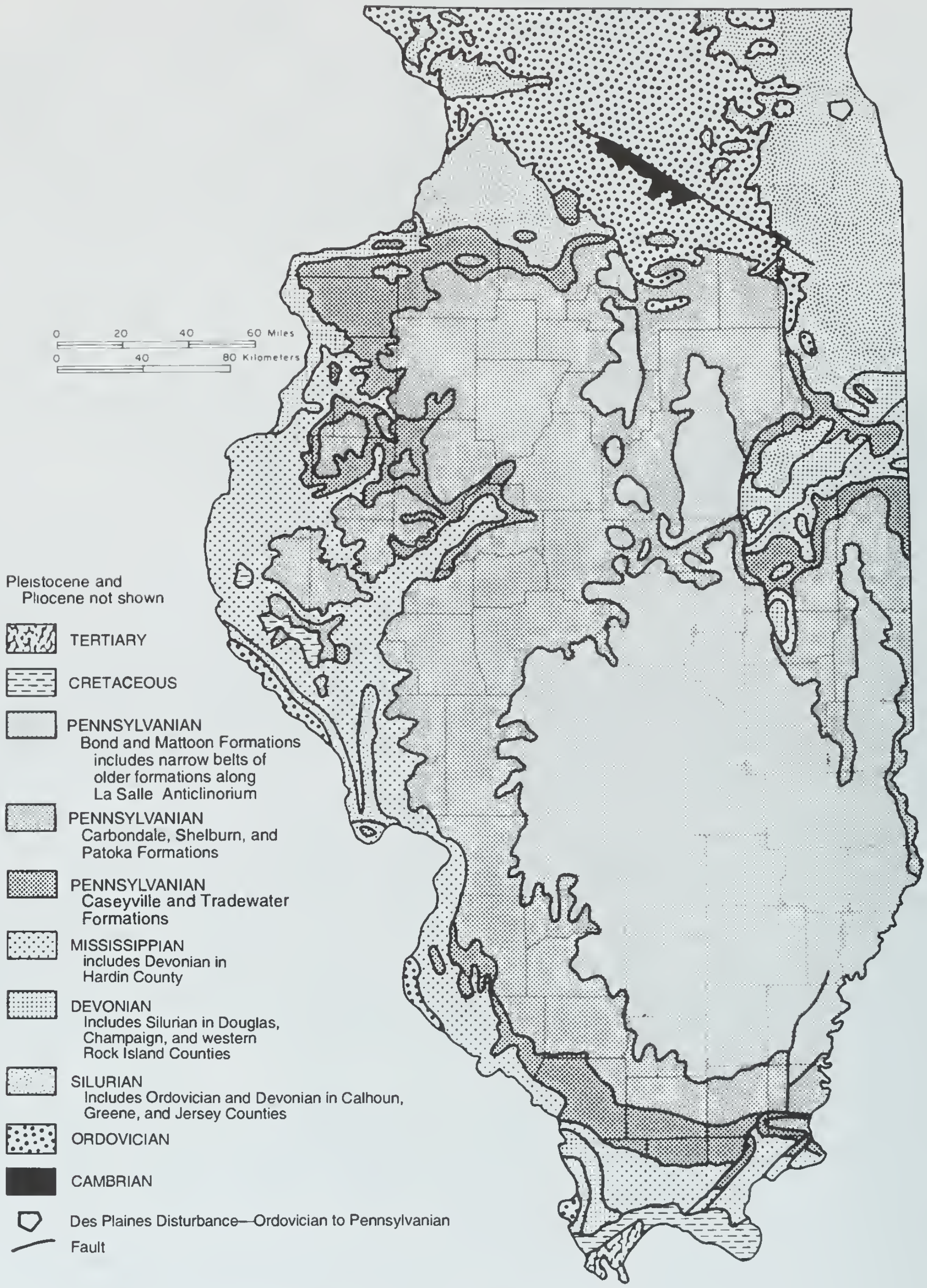


Figure 7 Bedrock geology beneath surficial deposits in Illinois.

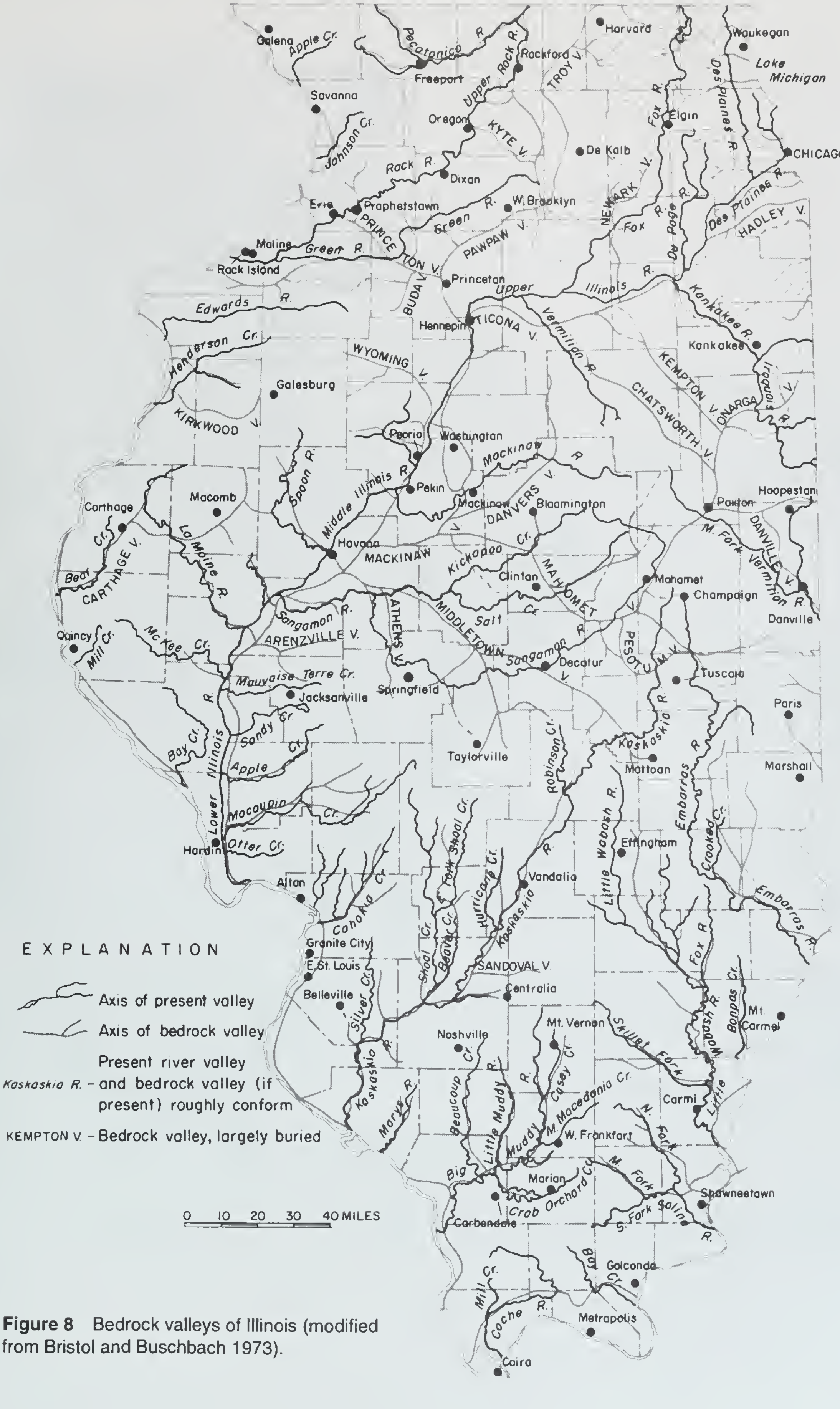


Figure 8 Bedrock valleys of Illinois (modified from Bristol and Buschbach 1973).

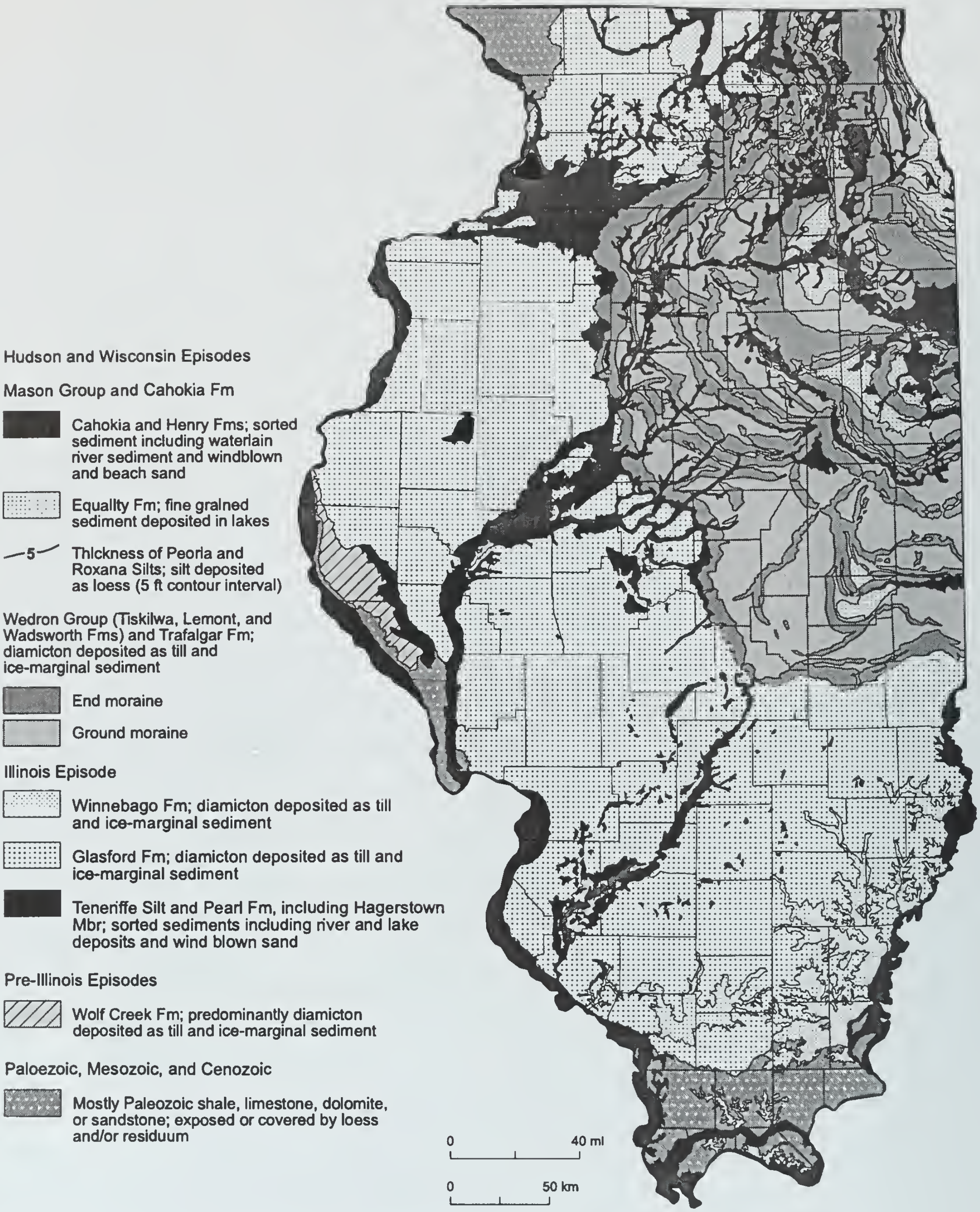


Figure 9 Generalized map of glacial deposits in Illinois (modified from Willman and Frye 1970).

that scoured and scraped the bedrock surface. This glacial erosion affected all the formations exposed at the bedrock surface in Illinois. The final melting of the glaciers left behind the nonlithified deposits in which our Modern Soil has developed.

Cenozoic Era: Glacial History As stated above, erosion that took place long before the glaciers advanced across the state left a network of deep valleys carved into the bedrock surface. As glaciation began, the streams probably stopped eroding and began to aggrade. That is, their channels began to build up and fill in because the streams did not have sufficient volumes of water to carry and move the increased volumes of sediment. These ancient stream valleys were completely filled by the outwash from later glaciations.

During the Pleistocene *Epoch*, beginning about 1.6 million years ago, massive sheets of ice (called continental glaciers) built up to thousands of feet thick and flowed slowly southward from Canada. During the Illinois Episode, which began around 300,000 years before the present (B.P.), North American continental glaciers reached their southernmost position, approximately 170 miles south of here, in the northern part of Johnson County (fig. 9). The last of these glaciers retreated (melted) from northeastern Illinois about 13,500 years B.P. The maximum thickness of these later Wisconsin Episode glaciers in Illinois was about 2,000 feet in the Lake Michigan Basin, but the ice was only about 700 feet thick over most of Illinois' land surface (Clark et al. 1988).

The *topography* of the bedrock surface throughout much of Illinois is largely hidden by glacial deposits, except along the major streams. In many areas, the glacial drift is thick enough to completely mask the underlying bedrock surface. Studies of mine shafts, water-well logs, and other drill-hole information, in addition to the scattered bedrock exposures in some stream valleys and roadcuts, show that the present land surface in the areas of Illinois where the glacial deposits are thickest does not reflect the underlying bedrock surface. The topography of the preglacial surface has been significantly modified by glacial erosion and is subdued by glacial deposits.

Although the Illinois Episode glaciers probably built morainic ridges similar to those formed by the later Wisconsin Episode glaciers, the Illinois Episode *moraines* apparently were not as numerous and have been exposed to weathering and erosion for approximately 280,000 years longer than their younger counterparts. For these reasons, Illinoian glacial features generally are not as conspicuous as the younger Wisconsinan features.

Overlying the glacial deposits is a thin cover of material called *loess* (pronounced "luss"). These sediments were deposited by the wind during all of the glacial episodes, from the earliest pre-Illinois Glacial Episode (approximately 1.6 million years ago) to the last glacial episode, the Wisconsin Episode (which occurred approximately 25,000 to 12,500 years ago). These loess deposits mantle the Pennsylvanian bedrock and glacial deposits throughout the field trip area.

GEOMORPHOLOGY

Physiography The field trip area is located at the junction of two prominent physiographic provinces (fig. 10). These include the southern portion of the Bloomington Ridged Plain and the northern portion of the Springfield Plain, both of the *Till Plains Section* of the *Central Lowland Physiographic Province* (fig. 10). The Till Plains Section is characterized by broad till plains that are relatively uneroded (a youthful stage of erosion), in contrast to the maturely eroded Dissected Till Plains on older drift sheets in Iowa.

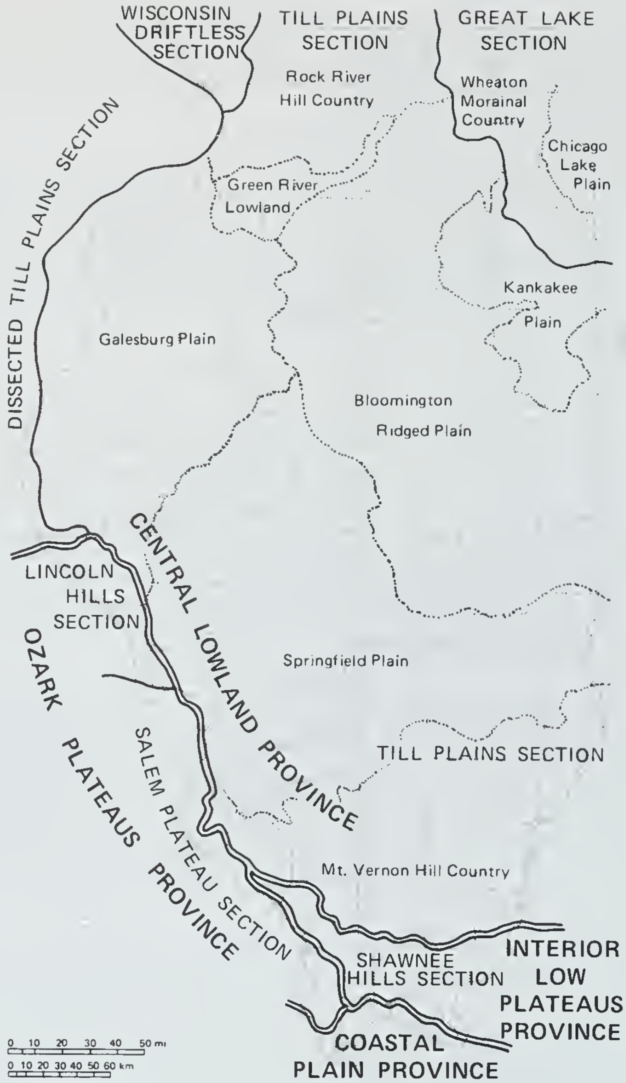


Figure 10 Physiographic divisions of Illinois.

As noted previously, the land surface had been extensively eroded prior to glaciation. Within the field trip area, erosion into the relatively weak rocks of Pennsylvanian age formed the Ancient Kaskaskia Bedrock Valley. As glaciation began, streams probably changed from erosion to aggradation; that is, their channels began to build up and fill in because the streams did not have sufficient volumes of water to carry and move the increased volumes of sediment (a process called alluviation). To date, no evidence indicates the early fills in these preglacial valleys were ever completely flushed out of their channels by succeeding glacial meltwater torrents.

• ***Springfield Plain*** The Springfield Plain includes the level portion of the Illinoian drift sheet in central and south-central Illinois (Leighton et al. 1948). It is distinguished mainly by its flatness and by shallow entrenchment of drainage. The southern boundary of the district is drawn along a line south of which the drift thins and bedrock topography becomes a controlling factor; the western boundary follows the edge of the Illinoian drift. The moraines are low and broad, but they are readily recognized because of their continuity. A large proportion of the hills and ridges appears to be kames and crevasse-fillings related to stagnant ice conditions.

Drainage systems are well developed, and the topographic relief (differences in elevations) is generally low between the uplands and the master-streams. The valleys are relatively shallow. Most of the principal streams have low gradients and occupy broad alluviated and terraced valleys; the secondary tributaries have wide V-shaped valleys; and the headwaters, flowing essentially on the till plain, have broad shallow valleys and low gradients.

The Illinoian drift is moderately thick and is underlain by older drift, except in areas where the bedrock is close to the surface. Only the larger valleys and uplands of the bedrock surface are reflected in the present topography.

• ***Bloomington Ridged Plain*** The Bloomington Ridged Plain includes most of the Wisconsin moraines and is characterized by low, broad morainic ridges with intervening wide stretches of relatively flat or gently undulatory ground moraine (Leighton et al. 1948). In many places, the major moraines rise with gentle slopes; although they are conspicuous from a distance, the major moraines become less so near at hand, whereas the minor moraines are prominent locally. In this district more than in any other, the grass-covered stretches of rolling prairie and extensive swamps described by early settlers were most typically and extensively developed.

The glacial deposits are relatively thick throughout the district and completely conceal the bedrock topography, except locally. Illinoian and older drift are present below the Wisconsin in most places, so that the level aspect of present drift plains is due largely to the presence of the older drift sheets, which filled in and covered the irregularities of the bedrock surface.

Drainage is generally in the initial stages of development, and most streams follow and are eroding in constructional depressions, many of which cross morainic ridges. The valleys of principal streams are large, owing in part to the greater areal extent of this division and to its somewhat greater age, and have floodplains bordered by valley-train terraces. The Illinois River, the master-stream of the district, has a broad, flat-bottomed valley with steep walls and is bordered by numerous narrow steep-walled valleys with steep gradients.

Drainage Within the field trip area, drainage is controlled by the Kaskaskia River and its tributaries (fig. 8). From its headwaters near the center of Champaign County, the Kaskaskia River flows in a generally southwesterly direction to the Mississippi River just north of Chester in Randolph County. The drainage basin is about 180 miles in length. However, because of the meandering nature of the Kaskaskia River, the total length of the river's course is approximately 320 miles. The portion of the Kaskaskia River Basin north of the Lake Shelbyville dam has a drainage area of 1,054 square miles. By the time the Kaskaskia River reaches the dam at Carlyle Lake, the drainage area has increased to 2,717 square miles; and by the time the Kaskaskia River reaches the Mississippi River, its drainage area equals 5,081 square miles.

Relief The highest land surface along the field trip route is located south of the community of Middlesworth in the SW SW, Section 12, Township 11 North, Range 4 East, where the surface elevation is 710 feet above mean sea level (msl). This topographic high point marks the crest of the Shelbyville Moraine. The lowest elevation encountered on the field trip is located within the Kaskaskia River flood plain at Stop 6 in the SW NW, Section 25, Township 11 North, Range 3 East, where the elevation is 550 feet above msl. The surface relief of the field trip area, calculated as the difference between the highest and lowest points, is 160 feet. *Local relief* is most pronounced along the bluffs surrounding Lake Shelbyville, where waves have cut back into the unconsolidated glacial deposits, and along the Kaskaskia River and its tributaries, where erosion has carved deep stream valleys.

UPPER KASKASKIA RIVER WATERSHED

The following description was obtained from the Illinois Environmental Protection Agency Web site at: htpp://www.epa.state.il.us/water/water-quality/fact-sheet-23.html

The Upper Kaskaskia River Watershed covers a total of 992,822 acres in Piatt, Champaign, Macon, Moultrie, Douglas, Coles, Shelby, and Fayette Counties. The largest cities in the watershed are Pana (5,796), Shelbyville (4,943), and Sullivan (4,354). Major streams which comprise the Upper Kaskaskia River Watershed include the Kaskaskia River, Robinson Creek, Marrowbone Creek, West Okaw River, Asa Creek, and Lake Fork. A total of 666 stream miles were assessed on the Upper Kaskaskia River and its tributaries. Overall resource quality is "good" on 606 stream miles (91%) and "fair" on 60 stream miles (9%). The primary causes of water quality problems are priority organics (mainly hydrocarbons, such as oils and gasolines) and organic enrichment (low dissolved oxygen) attributed to agricultural runoff. Two lakes covering 11,220 acres were also assessed in the watershed. Overall resource quality is "good" on 6,820 acres (61%) and "fair" on 4,400 acres (39%). The primary causes of water quality problems are nutrients, siltation, organic enrichment (low dissolved oxygen), and suspended solids attributed to agriculture and point sources.

Kaskaskia River A total of 114 stream miles of the Kaskaskia River are included in the Upper Kaskaskia River Watershed. Of the total, 97 miles were rated as "good," and 17 stream miles were rated as "fair" for the overall resource quality. Priority organics, metals, nutrients, and siltation were the primary causes of pollution due to the effects of urban runoff, agricultural runoff, and point sources. Numerous contaminants were detected in sediment and fish flesh from the mainstream of the Kaskaskia River. Elevated and highly elevated concentrations of chlordane, dieldrin, and heptachlor epoxide were present in sediment at monitoring sites upstream of Lake Shelbyville.

Lake Shelbyville Located in Shelby County, Lake Shelbyville is a public lake owned and managed by the U.S. Army Corps of Engineers. Lake Shelbyville was built in 1971 by damming the Kaskaskia River. Water from the Kaskaskia River and five other tributaries that lie within a 659,200-acre watershed flows directly into this 11,000-acre lake. At 11,000 acres, Lake Shelbyville is the third largest inland lake in Illinois. The overall resource quality of the lake is considered "good." Causes of pollution to the lake include nutrients, siltation, suspended solids, and organic enrichment (low dissolved oxygen). Sources include agriculture, shoreline erosion, recreational activities, and municipal point sources.

NATURAL RESOURCES

Mineral production Of the 102 counties in Illinois, 98 reported *mineral* production during 1995, the last year for which complete records are available. The total value of all minerals extracted, processed, and manufactured in Illinois during 1995 was $2,202,300,000, which is 10.9% lower than the 1994 total. Minerals extracted accounted for 87.6% of this total; processed crude minerals and manufactured minerals accounted for the remaining 12.4%. Coal continued to be the leading commodity, accounting for 64% of the total. Illinois is the fifth largest producer of coal in the nation, and is ranked 13th among the 31 oil-producing states and 16th among the 50 states in total production of nonfuel minerals, but it leads all other states in the production of sand and gravel, industrial sand, and tripoli (microcrystalline silica).

Shelby County ranked 79th among all Illinois counties in 1992 on the basis of the value of all minerals extracted, processed, and manufactured. Economic minerals currently mined in Shelby County include sand and gravel, stone, and crude oil. Sand and gravel mining is from glacial outwash and alluvium deposits. Oil production in 1992 totaled 52,000 barrels, and cumulative oil production equaled

2,318,000 barrels. Although no active coal mines are operating in Shelby County, historical cumulative production equals 4,119,763 tons.

Groundwater Groundwater is a mineral resource frequently overlooked in assessments of an area's natural resource potential. The availability of this mineral resource is essential for orderly economic and community development. More than 35% of the state's 11.5 million citizens and 97% of those who live in rural areas depend on groundwater for their water supply. Groundwater is derived from underground formations called *aquifers*. The water-yielding capacity of an aquifer can only be evaluated by constructing wells into it. After construction, the wells are pumped to determine the quality and quantity of groundwater available for use. Because glacial outwash valley train deposits occur in this area along the Kaskaskia River, the sand and gravel deposits are a significant source of groundwater. All the communities surrounding Lake Shelbyville are using groundwater, despite the presence of an abundance of water in Lake Shelbyville. The communities use groundwater because their water supply systems predate the construction of the lake.

STATE PARKS

Eagle Creek State Park is a 2,200-acre park on the west side of Lake Shelbyville, and Wolf Creek State Park is a 1,966-acre park on the east side of Lake Shelbyville. Both parks face each other across the central portion of the lake and provide the perfect setting for outdoor recreation and relaxed enjoyment of nature.

The parks encompass 11,100-acres of water, 250 miles of shoreline, and large tracts of carefully maintained indigenous woodland that is ideal for camping, hiking, horseback riding, snowmobiling, fishing, water skiing, pontoon boating, windsurfing, or just plain bobbing and drifting on the glittering expanse of the lake itself.

In addition to the small, friendly wooded campgrounds and the action on the lake, you can also take a leisurely stroll through nearby forests. An abundance of deer, pheasant, rabbit, wild turkey, and songbirds is almost always visible. Large herds of deer frequent the open areas and are always an exciting and inspiring sight.

Eagle Creek State Park Area has three marked nature trails that are available for tranquil and refreshing sojourns in the forest, a 12-mile backpack trail for the more adventurous hiker, and a 3-mile cross-country ski trail for invigorating wintertime activity. Wolf Creek State Park contains seven hiking trails, a 16½-mile snowmobile trail, and for the equestrian, a scenic 15-mile equestrian trail.

Swimming is available from the beach at Wolf Creek State Park, and Eagle Creek has a golf course. Both parks have boat-launching ramps where you can set out for a variety of water sports or lazy days of angling. In addition, two marinas on the lake provide a full range of boating and fishing supplies.

Like many other such areas, the Eagle Creek and Wolf Creek State Parks are perfect examples of the potential benefits of natural resource management. As a means of flood control, water supply, and downstream water quality control, the Flood Control Act of 1958 authorized the Shelbyville Reservoir Project, which involved construction of a dam and creation of a lake. These practical necessities, however, would also allow for the actual conservation of fish and wildlife and the development of areas for exciting and varied recreational opportunities.

The land occupied by the parks is now managed by the State of Illinois on a long-term lease from the federal government, which began in 1968. By 1972, the area was opened to the public and provided

primitive camping facilities. In the years since, the State has purchased additional surrounding lands and made extensive improvements in campground, boat launches, day-use areas, and hiking trails that make this a beautiful, well-tended and well-managed natural retreat. Portions of the park have been cleared of physical barriers and are accessible to disabled visitors.

The miles of flood brush, timber, and rock rip-rap shorelines, the many points with submerged ridges, and the hundreds of tributary streams emptying into Lake Shelbyville provide prime and productive fishing areas. The lake is teeming with black and white crappie, largemouth bass, walleye, channel and flathead catfish, bluegill, muskie, bullhead, carp, and sunfish.

For more information contact

Wolf Creek State Park	Eagle Creek State Park
Park Office	Park Office
R.R. 1, Box 99	R.R. 1, P.O. Box 6
Windsor, IL, 61957	Findlay, IL, 62534
(217) 459-2831	(217) 756-8260

LAKE SHELBYVILLE FISH AND WILDLIFE MANAGEMENT AREA

Located along the Kaskaskia and West Okaw Rivers near Sullivan, the Lake Shelbyville Fish and Wildlife Management Area offers some of the best canoeing, river fishing, and nature study opportunities in the state. The two areas contain 6,200 acres of mixed habitats including forest, prairies, restored grasslands, old field, brush, wetlands, rivers, streams, and cropland. All are situated in the upper reaches of the 34,000-acre Lake Shelbyville project area.

The Shelbyville Fish and Wildlife Area is composed of two separate units. The Kaskaskia (eastern) Unit covers 3,700 acres. The West Okaw (western) Unit contains about 2,500 acres. These are managed primarily to promote diverse habitats so that a wide variety of wildlife species are accommodated and related recreational opportunities are afforded the general public.

Oak, hickory, and hard maple flourish in the uplands, while cottonwood, sycamore, soft maple, and willow dominate the lowlands. This variety of species creates spectacular scenery as the foliage changes from green to the vivid reds, oranges, purples, and yellows of a showy Illinois fall.

Prairie plants can be found along railroad paths and rural roads, and in abandoned fields. Of special note is the unique, ½-acre Hill Prairie. This relic prairie jewel has been managed back to nearly its natural state. Located near the extreme southeast corner of the Kaskaskia Unit, the area is known to harbor over fifty species of native plants. Its summer bloom of purple and yellow cone flowers is, by itself, worthy of a visit to the site. An additional wealth of native wildflowers can by found in woodland under stories, along ditch banks, and in old field settings throughout the area.

Over 200 species of birds have been documented on the site since listing began in 1975. Seasonal displays featuring shorebirds, wading birds, waterfowl, wood warblers, raptors, and grassland and shrub habitat songbirds are a birdwatcher's delight. Resident game birds and game mammals are plentiful and offer the hunter opportunities not readily available in the intensely farmed areas dominating off-site landscapes. Bobwhite quail, ring-necked pheasant, mourning dove, woodcock, cottontail rabbit, white-tail deer, fox, gray squirrel, raccoon, muskrat, opossum, and mink are found in good numbers.

Portions of the area are managed under a farm lease program to promote upland wildlife habitat and wildlife on farm lands. Site personnel supplement natural habitats with tree and shrub plantings, native grass seedings, specialty food crop production, and succession control.

Wetland and marshland habitat management are emphasized in and around the five waterfowl management areas. By controlling the depth and duration of water on an area, significant amounts of natural moist-soil plants are produced. These, in turn, are used to provide breeding, courtship, feeding, and staging areas for wetland wildlife species including rails, snipe, herons, shorebirds, cormorants, ducks, and geese.

Canoeists and fishermen will find six small-boat launching facilities conveniently located in the wildlife areas. Visitors with bigger craft are advised to use the larger access areas offered at marinas, state parks, or Corps of Engineers' sites.

The Kaskaskia and West Okaw Rivers provide excellent stream fishing for walleye, white bass, crappie, and channel catfish. Boats are welcome on the rivers, but the corridors are designed as "no wake" areas.

Largemouth bass, bluegill, redear, and channel catfish are found in the six ponds scattered around the management units. These "farm" ponds range from 0.5 to 1.7 acres in size.

The Kaskaskia and West Okaw units offer developed nature trails that highlight the habitats found there. These trails provide visitors an opportunity to leisurely wander through natural settings that present different plant and animal communities at every turn. Whether a spring walk to look at wildflowers and marvel at woodland warblers, or a fall hike to take in fall leaf color, these trails showcase some of central Illinois' finest outdoor spectacles.

This area is governed by Federal Regulations (Title 36—Parks, Forests and Memorials) and Illinois Department of Conservation Administration Rules. Copies of these are available at agency offices on the lake. For additional information on this site, contact:

Site Superintendent
Shelbyville Fish and Wildlife Management
R. #1, Box 42-A
Bethany, IL 61914
(217) 665-3112

GUIDE TO THE ROUTE

The starting point for the Lake Shelbyville area field trip is at the boat ramp at Eagle Creek State Park, which is located in the southwest quarter of Sec. 7, T12N, R5E, of the Middlesworth Quadrangle in Shelby County. Mileage will start at the southwest corner of the boat ramp parking lot.

You must travel in the caravan. Please drive with headlights on while in the caravan. Drive safely but stay as close as you can to the car in front of you. Please obey all traffic signs. If the road crossing is protected by an Illinois State Geological Survey (ISGS) vehicle with flashing lights and flags, please obey the signals of the ISGS staff directing traffic. When we stop, park as close as possible to the car in front of you and turn off your lights.

Private property Some stops on the field trip are on private property. The owners have graciously given us permission to visit on the day of the field trip only. Please conduct yourselves as guests and obey all instructions from the trip leaders. So that we may be welcome to return on future field trips, follow these simple rules of courtesy:

- Do not litter the area.
- Do not climb on fences.
- Leave all gates as you found them.
- Treat *public* property as if you were the owner—which you are!

When using this booklet for another field trip with your students, a youth group, or family, remember that *you must get permission from property owners or their agents before entering private property.* No trespassing please.

Five USGS 7.5-Minute Quadrangle maps (Fancher, Kirksville, Middlesworth, Sullivan, and Shelbyville) provide coverage for this field trip area.

Miles from last point	Miles from start	
0.0	0.0	Exit the parking lot and TURN RIGHT. Follow this road to the entrance of the state park.
0.4	0.4	Y-intersection from the left. CONTINUE AHEAD. The road to your left will take you to the lodge and the golf course.
0.6	1.0	T-intersection from the left. This leads you to the park office and the information center for Eagle Creek State Park.
0.2	1.2	T-intersection from the right. Eagle Creek Camp Ground. CONTINUE AHEAD.
0.6	1.8	To your right is the beginning or end, depending on which way you look at it, of the Chief Illini Trail. This is an 11-mile trail along the western edge of Lake Shelbyville.
0.1	1.9	Leaving Eagle Creek State Park. Road makes a sharp 90° turn to the left.

0.6	2.5	T-intersection from the right (2025N and 2225E). CONTINUE AHEAD.
0.3	2.8	Stop (2-way). Crossroad intersection (2200E and 2025N). TURN RIGHT.
0.1	2.9	T-intersection from the right (2030N and 2200E). CONTINUE AHEAD.
0.6	3.5	Stop (1-way). T-intersection (Bruce-Findlay Road/2100N and 2200E). TURN RIGHT onto Bruce-Findlay Road toward Illinois State Route 32. The community of Findlay is to the left. We are heading east toward the community of Bruce.
0.2	3.7	T-intersection from the left (2225E and 2100N). CONTINUE AHEAD.
0.7	4.4	T-intersection from the left (2295E). CONTINUE AHEAD.
0.05	4.45	The county boundary between Shelby and Moultrie Counties is on the left. The south side of the road is in Shelby County, and the north side of the road is in Moultrie County.
0.1	4.5	T-intersection from the right (2300E). CONTINUE AHEAD.
0.5	5.0	Enter onto the west end of Findlay Bridge. Notice the view of Lake Shelbyville. Directly ahead and to your right and left, you can see the erosion that has occurred into the bluffs surrounding Lake Shelbyville.The 3,220-foot-long Findlay Bridge is reported to be the longest single-pillar suspended bridge in North America.
0.6	5.6	Exit the east end of Findlay Bridge.
0.9	6.5	T-intersection from the right (2500E). This is the road leading to Wolf Creek State Park. The gravel road to your left is a dead end. CONTINUE AHEAD.
0.7	7.2	T-intersection from the left. Timber Lake Golf Club is to the left. This road will take you to the Coal Shaft Bridge. CONTINUE AHEAD.
1.7	8.9	Crossroad intersection (2650E). CONTINUE AHEAD.
0.3	9.2	T-intersection from the left. Entrance to Whitley Creek Recreation area. CONTINUE AHEAD.
0.3	9.5	Crossroad intersection (unmarked). CONTINUE AHEAD.
0.5	10.0	CAUTION. Approaching intersection.
0.2	10.2	Stop (2-way). Crossroad intersection (Bruce-Findlay Road/2100N and Illinois State Route 32). CONTINUE AHEAD. Use caution when crossing Route 32.
0.7	10.9	Entering the community of Bruce. CONTINUE AHEAD.
0.2	11.1	Leaving the community of Bruce.
0.15	11.25	Crossing bridge over a small creek that feeds into Lake Shelbyville.

0.25	11.5	T-intersection from the right. CONTINUE AHEAD.
0.1	11.6	Crossing bridge. Backwater area of Lake Shelbyville is to the right.
0.7	12.3	Prepare to turn left. Waterfowl and wildlife management area to the left.
0.2	12.5	Crossroad intersection (13.00E and 8.00N). Turn left. Notice the flat, gently rolling topography of the land.
1.0	13.5	Crossroad intersection. CONTINUE AHEAD.
1.0	14.5	CAUTION: STOP. T-intersection (10.00N and 13.00E). TURN LEFT onto 10.00N. NOTE: No stop sign at this intersection.
0.4	14.9	Entering wildlife area.
0.1	15.0	View of Lake Shelbyville to your left.
0.1	15.1	Cone Flower Hill Prairie on the left side of the road. This unique 3.5-acre hill prairie is a relict prairie jewel that has been managed back to nearly a natural state. This area is known to harbor over 50 species of native plants. The summer bloom of the purple and yellow cone flowers is, by itself, worthy of a visit.
0.1	15.2	T-intersection from the left. Gravel road entrance to State of Illinois Natural History Survey Field Office. On the day of the field trip, we will CONTINUE AHEAD down to the parking lot, turn around, and come back to the Illinois Natural History Survey Area.
0.2	15.4	T-intersection from the right. TURN RIGHT. The road straight ahead is closed. Sign: *Bridge out ahead.*
0.25	15.65	Parking area at boat ramp. We will turn around and head back toward the Natural History Field Office.
0.35	16.0	STOP. T-intersection. TURN LEFT. Road to the right is barricaded off.

0.2	16.2	**STOP 1 Kaskaskia Biological Station, Illinois Natural History Survey Laboratory** Stop 1 is located in the SW, Sec. 19, T13N, R6E, on the Sullivan 7.5-Minute Quadrangle in Moultrie County.

0.0	16.2	Leave Stop 1 and CONTINUE AHEAD.
0.1	16.3	Cone Flower Hill Prairie to the right. CONTINUE AHEAD.
0.15	16.45	Leaving wildlife area.
0.45	16.9	T-intersection from the right (13.00E and 10.00N). TURN RIGHT.

0.95	17.85	Crossroad intersection. CONTINUE AHEAD.
1.0	18.85	STOP (2-way). Intersection (13.00E and 8.00N). TURN RIGHT. This is the Bruce-Findlay Road.
0.85	19.7	Cross bridge over Whitley Creek.
0.2	19.9	T-intersection from the left. CONTINUE AHEAD.
0.2	20.1	Cross bridge over backwater area of Lake Shelbyville.
0.15	20.25	Enter the community of Bruce.
0.2	20.45	Leaving the community of Bruce. CONTINUE AHEAD.
0.65	21.1	STOP (2-way). Crossroad intersection (Illinois Route 32). CAUTION: fast moving cross traffic does not stop. CONTINUE AHEAD. To your right is the city of Sullivan, and to the left is the community of Windsor.
0.8	21.9	Crossroad intersection. CONTINUE AHEAD.
0.2	22.1	T-intersection from the right. Road leading to Whitley Creek Recreational Area. CONTINUE AHEAD.
1.25	23.35	Crossroad intersection. CONTINUE AHEAD.
0.75	24.1	T-intersection from the right. CONTINUE AHEAD. This road takes you to the Timber View Golf Course.
0.2	24.3	Crossing natural gas pipeline. CONTINUE AHEAD.
0.6	24.9	Crossroad intersection (2500E and 2500N). TURN LEFT toward Wolf Creek State Park.
0.5	25.4	T-intersection from the left (2050N). Sign says road is closed during high water.
0.4	25.8	Crossing bridge.
0.05	25.85	Sugar Maple access area to the right and gravel road to the left. CONTINUE AHEAD.
1.05	26.9	T-intersection from the left (1900N and 2500 E). CONTINUE AHEAD.
0.3	27.2	Leprechaun Landing Mini-Mart is on the left, and the entrance to Wolf Creek State Park is straight ahead. Deerfield Bed and Breakfast is on the left.
0.3	27.5	T-intersection from the right. Sign at intersection: Quigley Cemetery, Group Camp, Horse Camp, and Horse Stables. TURN RIGHT and head toward Quigley Cemetery.
0.1	27.6	T-intersection from the left. TURN LEFT. Heading toward Quigley Cemetery.

0.2	27.8	**STOP 2 Quigley Cemetery – Wolf Creek State Park** Take the trail to the lake that begins on the west edge of the parking lot.
0.0	27.8	Leave Stop 2. Retrace route back to the main park road. Many of the tombstones in the Quigley Cemetery have dates from the 1850s and 1860s, and name several Civil War veterans.
0.2	28.0	T-intersection. TURN RIGHT.
0.1	28.1	STOP (1-way). T-intersection. TURN RIGHT.
0.3	28.4	Park office to the right.
0.25	28.65	T-intersection from the left, which leads to the camp ground. CONTINUE AHEAD. Follow the sign leading to boat ramp, beach, picnic areas, and hiking trail.
0.45	29.1	T-intersection from the right. Picnic areas of the Lost Shelter and Red Fox overlook are straight ahead. CONTINUE AHEAD toward overlook.
0.55	29.65	T-intersection from the right. Wolf Creek Beach. CONTINUE AHEAD.
0.05	29.7	Y-intersection. Overlook is to the right and the boat ramp is to the left. TURN RIGHT toward the overlook.
0.55	30.25	**STOP 3 Lunch: Lost Shelter Picnic Area – Wolf Creek State Park** Circle the cars around the loop. We will park on each side of the road at the overlook picnic area.
0.15	30.4	Leave the overlook picnic area and follow the road back toward the park entrance.
0.55	30.95	Y-intersection. Boat ramp is to the right and entrance to the state park is to the left. TURN LEFT. Entrance to the beach is to the left, just after you make the left-hand turn.
1.05	32.0	T-intersection from the right, which leads to the camp grounds. CONTINUE AHEAD. Unmarked road.
0.1	32.1	T-intersection from the left. CONTINUE AHEAD.
0.1	32.2	Sewage ponds to the right.
0.05	32.25	Park office to the left. CONTINUE AHEAD.
0.3	32.55	T-intersection from the left, which leads to Quigley Cemetery, group camp, horse camp, and riding stables. CONTINUE AHEAD.

0.25	32.8	Leaving Wolf Creek State Park.
0.4	33.2	T-intersection from the right (1900N and 2500E). TURN RIGHT onto 1900N.
0.5	33.7	T-intersection from the right (2550E). CONTINUE AHEAD.
0.1	33.8	Crossing underground gas lines from the Natural Gas Pipeline Company of America, Hammond, Illinois, 217/262-3298 or 1-800/733-2490.
0.2	34.0	Exposure of till on the right side and the creek.
0.2	34.2	T-intersection (1900N and 2600E). TURN RIGHT heading south.
0.9	35.1	Cross bridge over Sand Creek. Notice the wave-cut bluffs along Sand Creek. Lake Shelbyville is to your right.
0.6	35.7	CAUTION: Crossroad intersection (2600E and 1750N). No stop signs. CONTINUE AHEAD. Watch for traffic in both directions.
0.5	36.2	CAUTION: Crossroad intersection (2600E and 1700N). No stop signs. CONTINUE AHEAD.
0.5	36.7	T-intersection from the right (1650N). Sign indicates Windsor Gun Club to the right. CONTINUE AHEAD.
0.2	36.9	T-intersection from the left (1625N). CONTINUE AHEAD.
0.3	37.2	T-intersection from the right (1600N). CONTINUE AHEAD. Road to the right is marked as a dead end.
0.3	37.5	A small unmarked cemetery is hidden within the weeds on the right-hand side of the road. A single, large oak tree is located just past the cemetery.
0.2	37.7	T-intersection (1550N). No stop sign. TURN RIGHT.
0.1	37.8	Road jogs to the left and back to the right, and then makes a sharp 90° turn to the left.
0.2	38.0	Road makes 90° turn to the right.
0.2	38.2	Road makes 90° turn to the left. This is 2550E.
0.4	38.6	STOP (2-way). Crossroad intersection (1500N and 2550E). TURN RIGHT. Cross traffic does not stop.
0.25	38.85	Crossing Natural Gas Pipeline Company of America underground pipelines. Substation is located on the left side of the road. The underground pipeline has been marked by three colors: green, red, and yellow. The red one is marked “line one Windsor”; yellow is marked “line two Windsor.”
0.35	39.2	T-intersection from the right (2500E). CONTINUE AHEAD.

0.1 39.3 Crossing Skull Creek; narrow bridge.

0.4 39.7 T-intersection from the left (2450E). CONTINUE AHEAD.

0.3 40.0 Water tower and radio tower on the right side of the road.

0.2 40.2 T-intersection from the right (2400E). CONTINUE AHEAD. Water tower is located just north and east of the intersection.

0.05 40.25 Road leading to radio tower.

0.95 41.2 T-intersection from the left (2300E and 1500N). CONTINUE AHEAD.

The road to the left (south) leads to the entrance of Lithia Springs, approximately 0.3 miles south of this intersection. The springs are located near the center of the SE NE, Sec. 2, T11N, R4E, on the Middlesworth 7.5-Minute Quadrangle. The spring was named Lithia because the water was reported to contain the element lithium. Although an analysis of the water in 1890 failed to detect any lithium, this did not deter the claims of the water's medicinal benefits. The water from these springs was reportedly sold and shipped in kegs and barrels to New Orleans, California, and other distant places. Lithia Springs is the site of the historic Lithia Springs Chautauquas. There seem to be several possible meanings or definitions for the term Chautauqua. One is that it is derived from a Seneca Indian word meaning “the fish leaps”; a second is that it is an Indian word for “gathering place.” Regardless of its original meaning, the first Chautauqua was held at Chautauqua, New York, in the late 1880s, and was originally planned as a summer school for Sunday School teachers but quickly grew to encompass an entire popular educational movement. By 1890 there were approximately 200 of these small assemblies throughout the country, and 1,000 by 1912. Reverend Jasper L. Douthit adopted the term for his famous religious meetings, which started at this site in1890 and continued until 1920. Although the buildings no longer remain, the visitor can walk through this tranquil valley and find traces of the old buildings. Many of the foundations are still present and provide the visitor just enough insight to imagine the valley as it was in the 1890s. A stroll back into the woods will lead you to the springs, which still flow.

1.0 42.2 STOP (4-way). Crossroad intersection (2200E and 1500N). TURN LEFT. Straight ahead is the Bob Bitzer Memorial Highway. The road straight ahead will lead you to Lithia Springs Access Area.

0.3 42.5 View of Lithia Springs Marina on the right.

0.1 42.6 Crossing Lithia Springs Bridge. Once again, notice the wave-cut bluffs along the shore of Lake Shelbyville to your right and along portions of the Lithia Springs Creek on your left.

0.3 42.9 T-intersection from the left (1430N). CONTINUE AHEAD.

0.8 43.7 Crossroad intersection (1550N and 2200E). Dead end road on the right. CONTINUE AHEAD.

		Between 1350N and 1300N, we cross the abandoned railroad grade for the Conrail Railroad Company.
0.5	44.2	STOP (2-way). Intersection (1300N/Illinois State Route 16 and 2200E). TURN RIGHT. Just south of this intersection is a single oil well in Section 15.
0.6	44.8	T-intersection from the right (2140E). CONTINUE AHEAD.
0.4	45.2	Crossroad intersection (2100E). CONTINUE AHEAD.
0.6	45.8	Highway splits into a divided highway.
0.4	46.2	T-intersection from the right (1995E). TURN RIGHT. Entering Dam East Recreation Area and Lake Shelbyville Visitors Center.
0.1	46.3	T-intersection from the right. CONTINUE AHEAD on the main road toward Shelbyville Dam. Road makes a 90° turn to the left just past the T-intersection.
0.1	46.4	Road to the right leads to the visitors center.
0.05	46.45	Administrative offices on the left side of the road.
0.05	46.5	T-intersection from the left. TURN LEFT and follow the road to the base of the dam. The road straight ahead will allow you to cross the dam.

0.4	46.9	**STOP 4 Lake Shelbyville Dam – Spillway Access Area** The picnic area is located at the base of the dam. On the day of the field trip, pull over and parallel park in the parking lots and along the road at the base of the spillway.

0.0	46.9	Leave Stop 4 and CONTINUE AHEAD to the intersection with Illinois State Route 16.
0.1	47.0	STOP (1-way). Intersection of Illinois State Route 16 and Spillway Access Area road. TURN RIGHT.
0.1	47.1	Cross the Kaskaskia River. View of Lake Shelbyville Dam to the right. The city of Shelbyville is directly ahead and is situated on top of the Shelbyville Moraine. Note: We will be following Route 16/Main Street through the city of Shelbyville.

About Shelbyville The history of the city begins with Barnett Bone, a Tennessean, who in 1835 built a log cabin along the Kaskaskia River. His cabin later became the county courthouse. The first businesses were blacksmith shops (with hand forges fueled by coal found in the area), a general store and stagecoach stop, and a grist mill. By the 1890s, the railroad had put Shelbyville on the map with five trains passing through each way everyday. Between 1900 and 1933, coal mining was a major industry in the Shelbyville area. Miners such as Dutch and Red Phelps, Doc Keller, Charley Parker, and Shorty Root lay on their

sides to chip coal in seams up to 48 inches thick. In the midst of the Depression, rising insurance rates and competition from petroleum products closed the mines.

Shelby County was created in 1827 by an act of the Illinois Legislature. It was named after the first governor of Kentucky and Revolutionary War hero, Isaac Shelby. Legend has it that the Illinois governor Ninian Edwards, hoping to motivate the three commissioners charged with laying out the new county, sent them from Springfield with a keg of rye whiskey, telling them they could open it when a site for the county seat had been found. The keg was opened on the bluffs of the Kaskaskia River, where the Shelby County Courthouse now stands.

0.3	47.4	Caution: Cross Union Pacific railroad tracks. Guarded crossing with signal lights and guard gates.
0.05	47.45	The Shelby County Courthouse is to the right. The Courthouse was designed by O.H. Placey of Chicago, and built in 1879–1881. Several historic paintings are in the Courthouse, including Robert Root's depiction of the Abraham Lincoln–Anthony Thornton Debate that took place in Shelbyville and launched Lincoln's national political careeer. The clocks in the main dome were taken from the old Main Street School.
0.1	47.55	Stoplight. Intersection of Main Street/Route 16 and Morgan Street. CONTINUE AHEAD.
0.1	47.65	Stoplight. Intersection of Main Street/Route 16 and Broadway Street. CONTINUE AHEAD.
0.75	48.4	Stoplight. Intersection of Main Street/Route 16 and Cedar Street. CONTINUE AHEAD.
0.5	48.9	Stoplight. Intersection of Main Street/Route 16 and Henlien Drive. CONTINUE AHEAD.
0.2	49.1	Cross Swafford Branch of Robinson Creek.
0.75	49.85	T-intersection from the right (Route 16/1300N and Petty Lane/1640E). CONTINUE AHEAD.
0.45	50.3	T-intersection from the left (Route 16/1300N and Sylvestar Drive/1600E). TURN LEFT onto 1600E. Shelbyville Airport is to the right.
0.35	50.65	Cross over abandoned Conrail railroad grade. The tracks have been removed. Located on the left and just north of the abandoned tracks is the Chicap Pipeline Company pumping station.
0.05	50.7	A small section of land to the left has been set aside by the landowner as part of the Illinois Acres for Wildlife program.
0.05	50.75	Cross underground petroleum pipeline.
0.5	51.25	T-intersection from the left (1200N). CONTINUE AHEAD.
0.35	51.6	Cross Swafford Branch of Robinson Creek

0.15	51.75	T-intersection from the right (1150N). CONTINUE AHEAD.
0.5	52.25	STOP (3-way). Y-intersection (1600E and 1100N). TURN LEFT onto 1100N.
0.3	52.55	Cross small unnamed branch of Robinson Creek.

0.2	52.75	**STOP 5 North Water Well Field** The water well field is located on the south side of the road. Pull over to the right side of the road and park.

0.0	52.75	Leave Stop 5. CONTINUE AHEAD.
0.5	53.25	STOP (2-way). Crossroad intersection (1100N and 1700E). TURN RIGHT onto 1700E.

0.65	53.9	**Stop 6 Prosser Sand and Gravel Pit** (left side of the road).

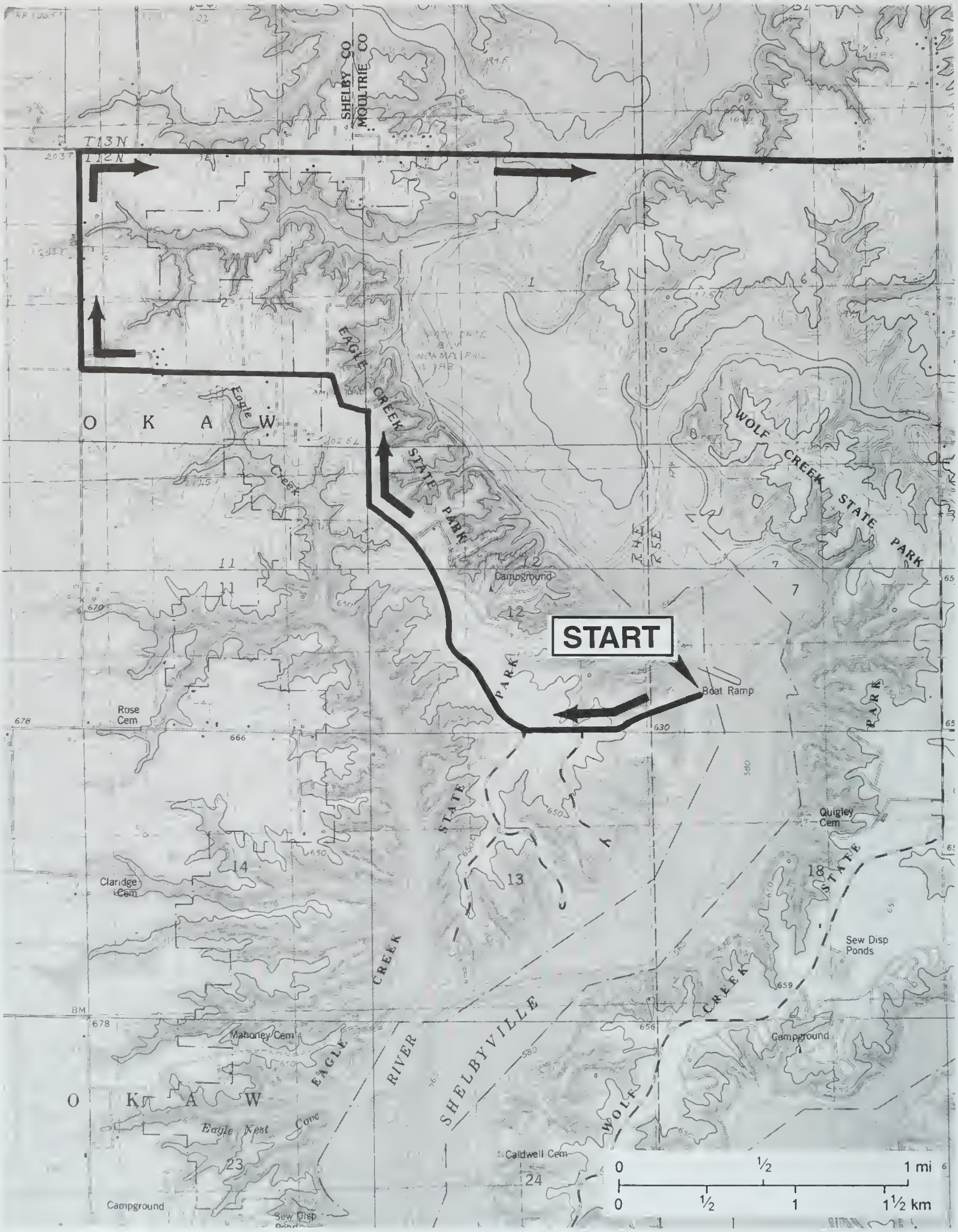
0.0	53.9	**End of trip** Leave Stop 6.

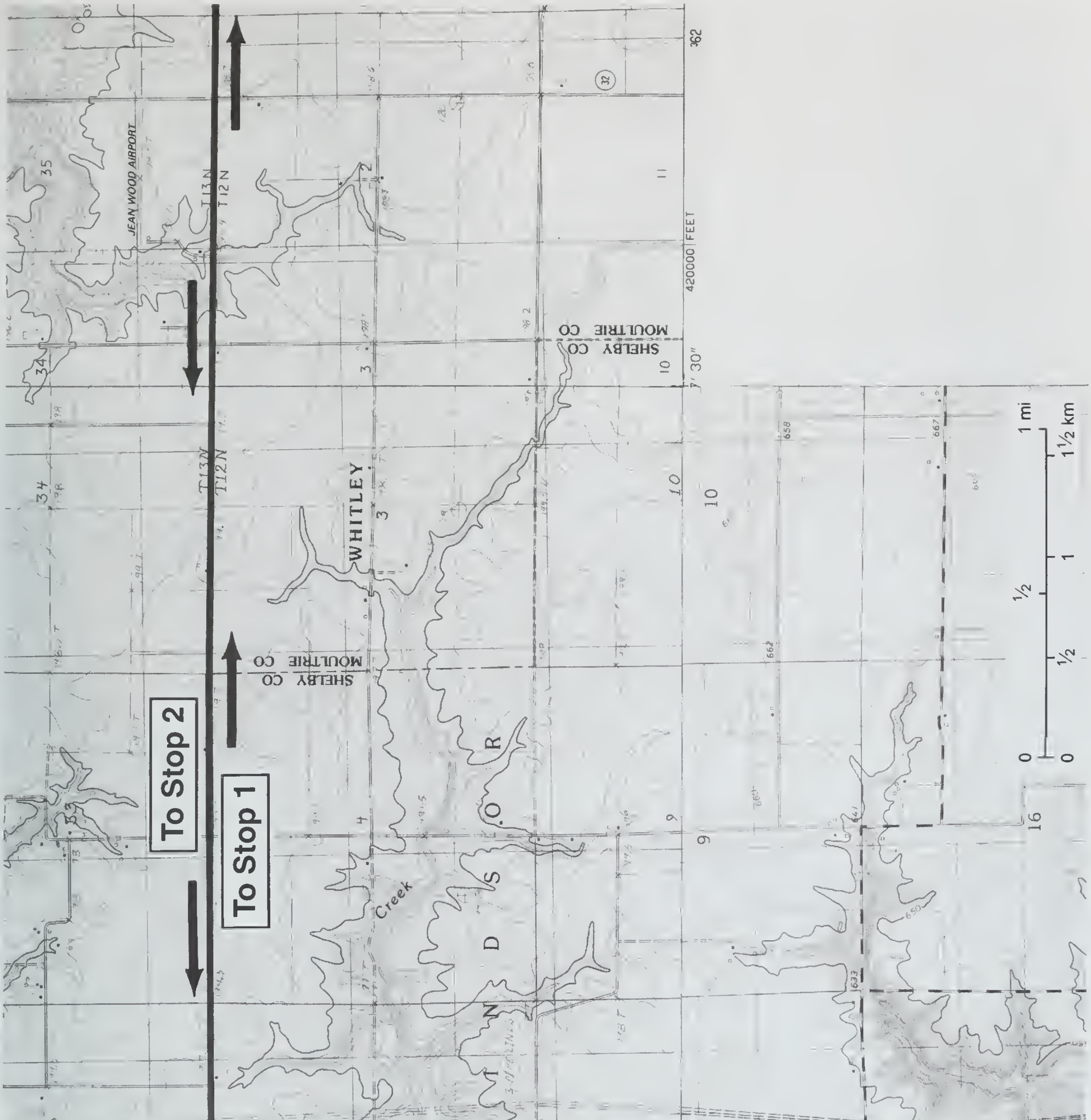
The following road log will guide you back to Shelbyville. Reset your odometer to (0.0).

0.0	0.0	Turn around and head north from the sand and gravel pit. This road is 1700E.
0.65	0.65	STOP (2-way). Crossroad intersection (1700E and 1100N). TURN RIGHT onto 1100N.
0.7	1.35	Road makes a 90° turn to the left.
0.5	1.85	Road makes a 90° turn to the right.
0.3	2.15	STOP (1-way). T-intersection (1150N and 1800E). TURN LEFT onto 1800E.
1.5	3.65	Stoplight. Crossroad intersection of Cedar Street/Route 128 and Main Street/ Route 16.

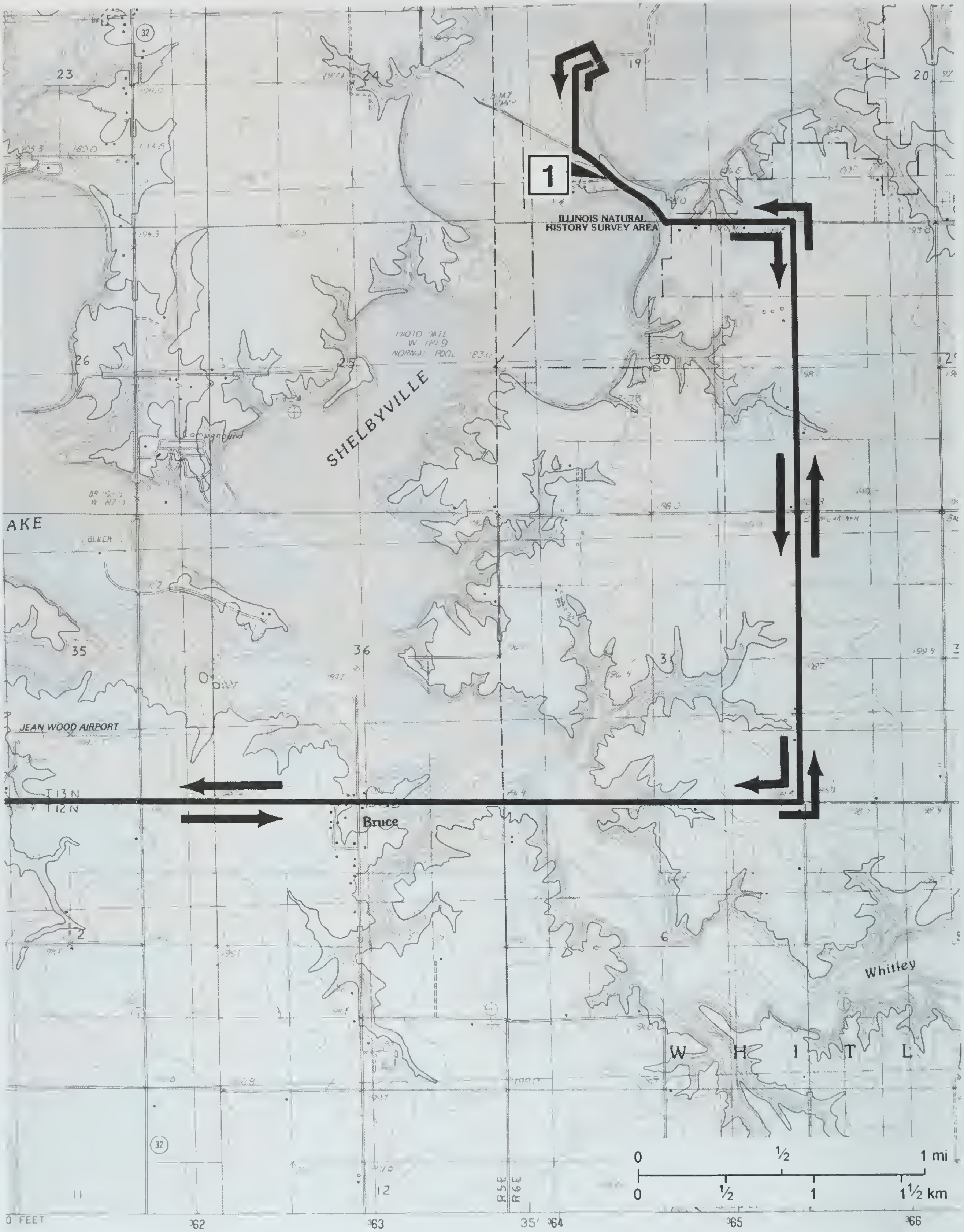
Have a safe trip home and please join us on either November 7, 1998, or April 10, 1999, for the La Rue Pine Hills Area Geological Science Field Trip in southwestern Illinois, or on May 22, 1999, for the Rock Island-Moline Area Geological Science Field Trip in northwestern Illinois.

SUPPLEMENTAL Stop 7 Copeland Bridge This stop is included in the field trip guide book for use by others wishing to visit and discover other areas of geological significance in the Lake Shelbyville area. The location of the stop is marked on the road log maps found in the guidebook.

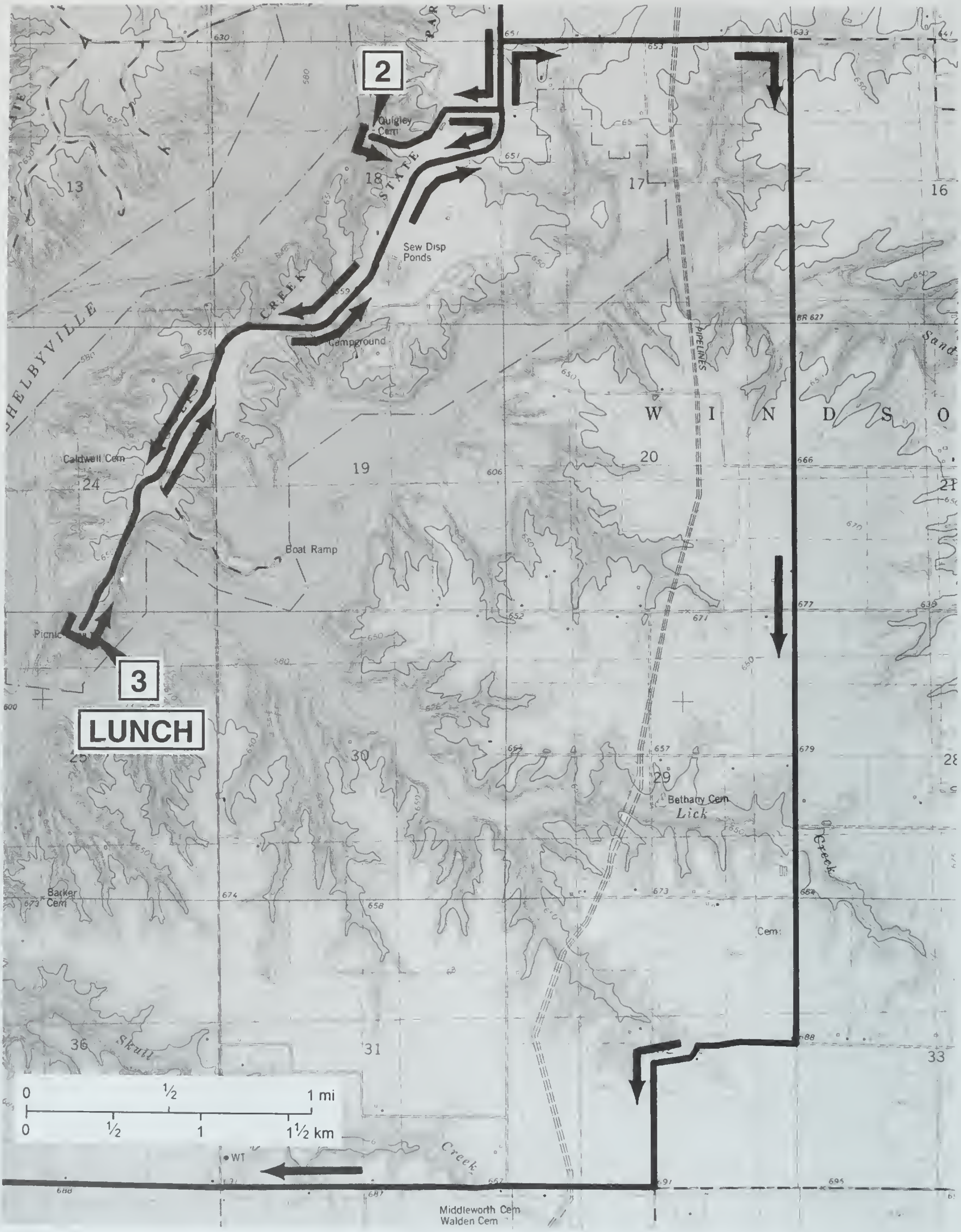

SHELBY CO
MOULTRIE CO
T13N
T12N
O K A W
Eagle Creek
EAGLE CREEK STATE PARK
WOLF CREEK STATE PARK
Campground
START
Boat Ramp
Rose Cem
Claridge Cem
Quigley Cem
Sew Disp Ponds
Campground
Mahoney Cem
EAGLE CREEK
RIVER
SHELBYVILLE
WOLF CREEK
O K A W
Eagle Nest Cove
Caldwell Cem
Campground
Sew Disp Ponds
STATE PARK
0 ½ 1 mi
0 ½ 1 1½ km

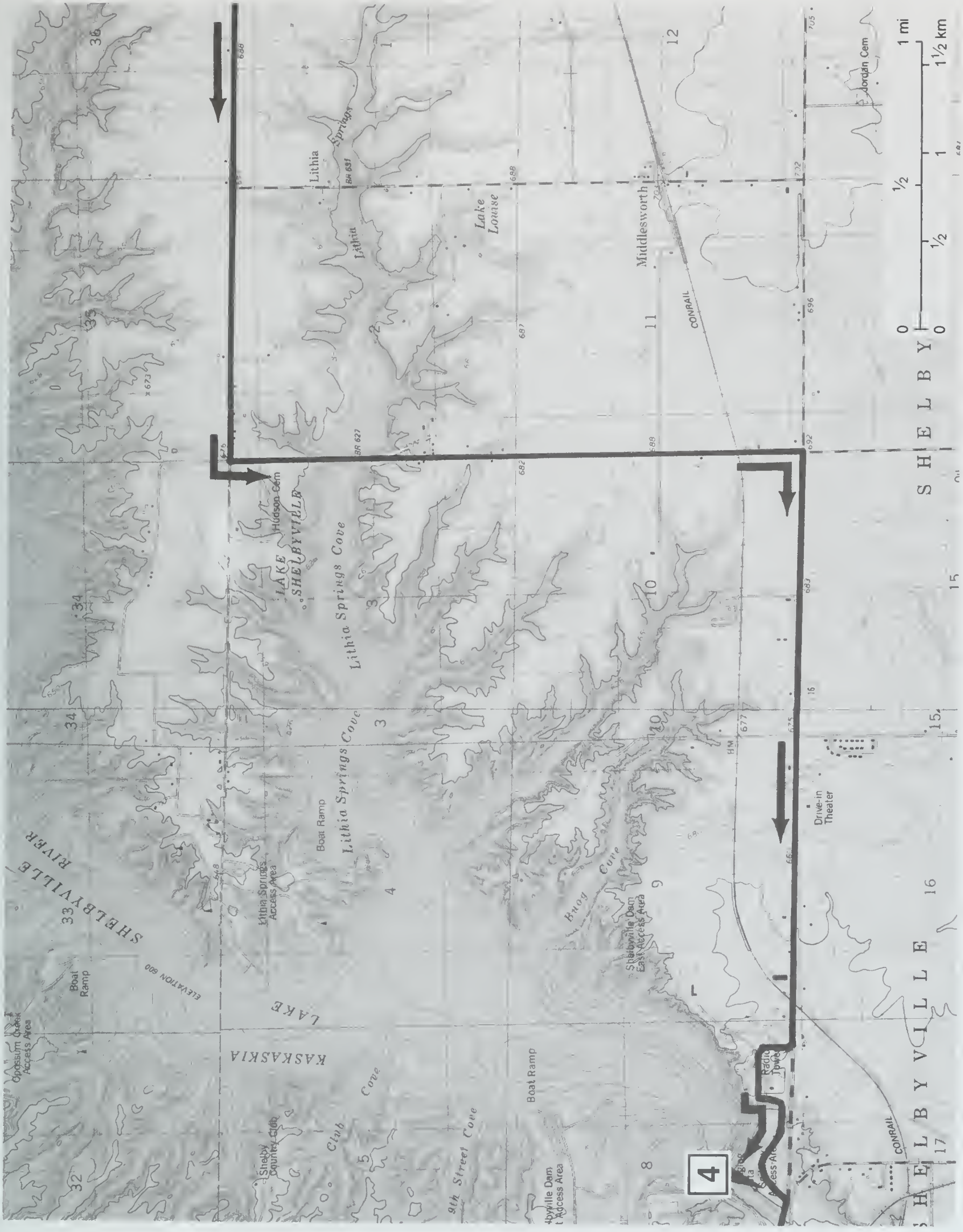


To Stop 1
To Stop 2
To Stop 2
JEAN WOOD AIRPORT
T13N
T12N
WHITLEY
SHELBY CO
MOULTRIE CO
Wolf
Creek
W I N D S O R
PARK
420000 FEET
0
1/2
1
1 mi
0
1/2
1 1/2 km

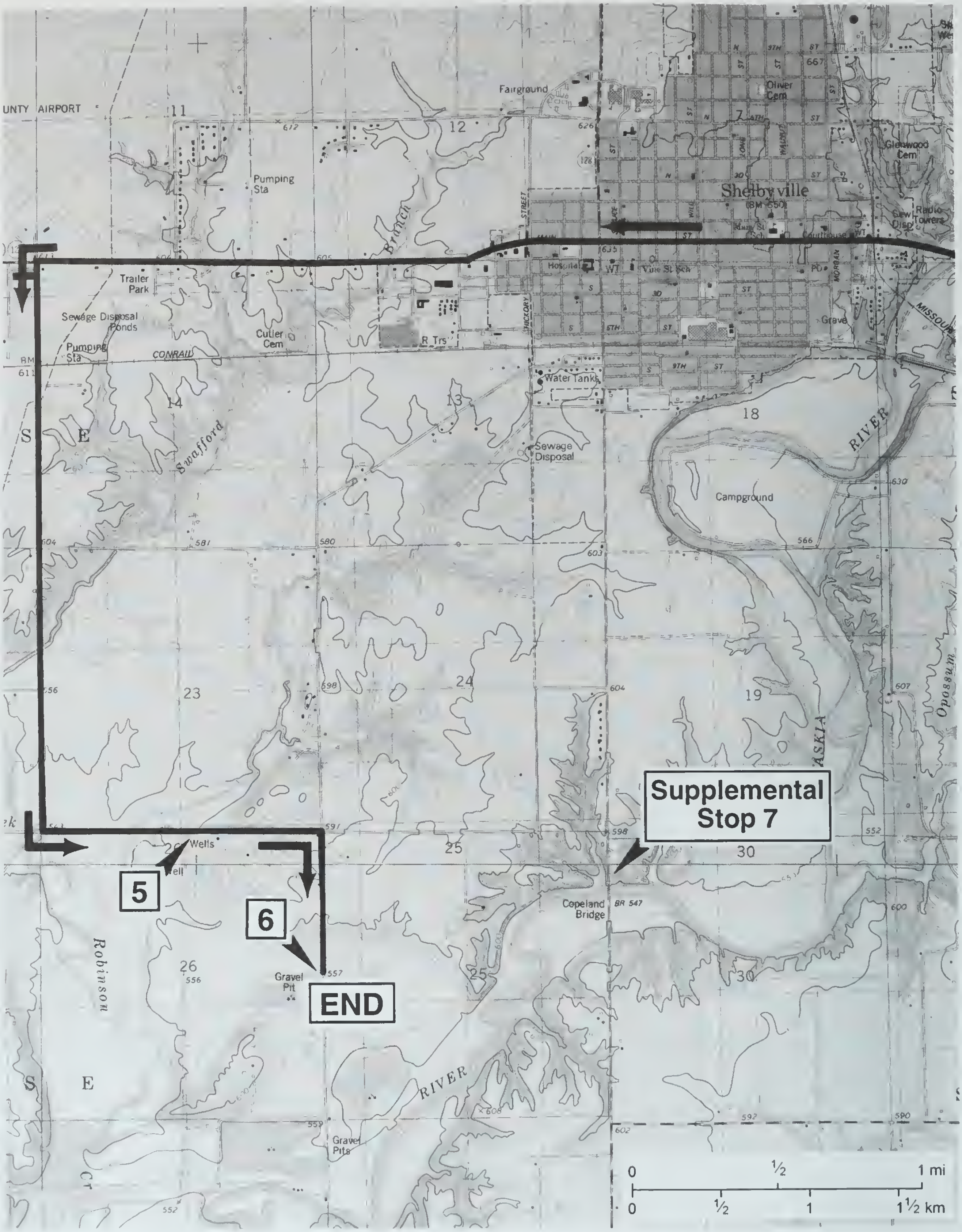

1
ILLINOIS NATURAL HISTORY SURVEY AREA
SHELBYVILLE
AKE
JEAN WOOD AIRPORT
Bruce
Whitley
W H I T L
T13N
T12N
R5E
R6E
0 ½ 1 mi
0 ½ 1 1½ km


T13N
T12N
420000 FEET
SHELBY CO
MOULTRIE CO
WHITLEY
W I N D S O R
Wolf
Creek
New Liberty Ch
WOLF CREEK STATE PARK
STATE
Quigley Cem
Sew Disp Ponds
Campground
PIPELINES
Sand
2
0
1/2
1 mi
1
1 1/2 km

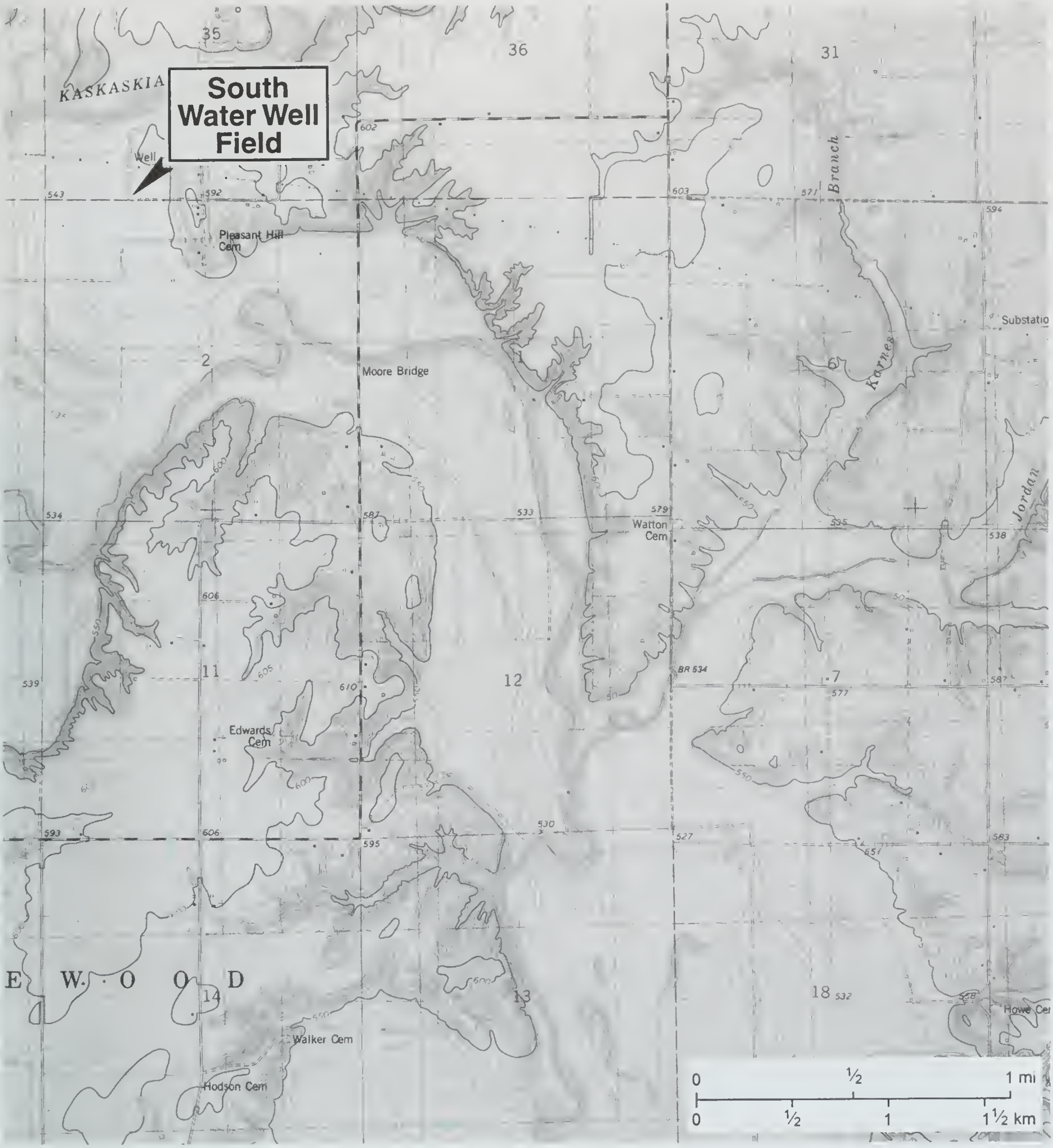

2
3
LUNCH
Quigley Cem
Sew Disp Ponds
Campground
Caldwell Cem
Boat Ramp
Picnic
Barker Cem
Bethany Cem
Lick
Creek
Cem
Middleworth Cem
Walden Cem
WT
SHELBYVILLE
CREEK
STATE
PIPELINES
W I N D S O
Skull
Creek
0 ½ 1 mi
0 ½ 1 1½ km



4
SHELBYVILLE
LAKE SHELBYVILLE
Hudson Cem
Lithia Springs Cove
Lithia Springs
Lithia
Lake Louise
Middlesworth
CONRAIL
Drive-in Theater
Buoy Cove
Shelbyville Dam East Access Area
Lithia Springs Access Area
Boat Ramp
SHELBYVILLE RIVER
ELEVATION 600
KASKASKIA LAKE
Opossum Creek Access Area
Shelby Country Club
Club Cove
9th Street Cove
Jordan Cem
1 mi
1½ km



Supplemental
Stop 7
5
6
END
Shelbyville
Fairground
Oliver Cem
Glenwood Cem
Pumping Sta
Trailer Park
Sewage Disposal Ponds
Cutler Cem
Hospital
Water Tanks
Sewage Disposal
Campground
Copeland Bridge
Wells
Gravel Pit
Gravel Pits
Swafford
Robinson
RIVER
CONRAIL
0
½
1 mi
0
½
1
1½ km



South Water Well Field
KASKASKIA
Well
Pleasant Hill Cem
Moore Bridge
Watton Cem
Edwards Cem
Walker Cem
Hodson Cem
Substatio
Howe Cer
Branch
Karnes
Jordan
E W O O D
0 ½ 1 mi
0 ½ 1 1½ km

STOP DESCRIPTIONS

START Eagle Creek State Park – Boat Ramp (SE SW SW, Sec. 7, T12N, R5E, 3rd PM, Shelby County, Middlesworth 7.5-Minute Quadrangle)

STOP 1 Kaskaskia Biological Station, Illinois Natural History Survey Laboratory (SE and SW of the SW, Sec. 19, T13N, R6E, 3rd PM, Moultrie County, Sullivan 7.5-Minute Quadrangle)

The Kaskaskia Biological Station is run by the Illinois Natural History Survey, a division of the Department of Natural Resources. Research conducted at the station involves studying fish populations and their interactions with their environment. The results of these studies are used to develop better management strategies for fish in Illinois. Research is being conducted in Lake Shelbyville as well as many other lakes across the state. Some of the questions being answered through research at the station include: What is the best size to stock walleye? How can we create quality bluegill fishing in Illinois? What are the best stocking strategies for largemouth bass and how can we improve their natural reproduction?

Much of the work at the Kaskaskia Biological station involves the collection of specimens from the field. Fish, invertebrates, vegetation, and water chemistry are all sampled in the field using various collection methods and tools. Collection of fish often involves a certain type of net (passive or active) or electrofishing. Nets that are fished passively entangle or entrap fish and are left in the body of water for a set period of time until they are retrieved and the fish are removed. Some examples of passive nets include gill nets and trap nets. Actively fished nets, such as seines and trawls, sieve fish from the water. Seines are often used to collect smaller fishes inshore and are used by pulling them along the shoreline. Electrofishing is another technique for collecting fish. A generator inside the boat produces electricity that is transferred into the water. Fish drawn to the electric field are stunned and netted with a dip net. Once the fish have been collected, they are weighed and measured. In addition, scales are removed for ageing, and stomach contents are removed to determine what the fish are eating. The data collected by these methods and tools can be used for estimating population size, structure, and diet. Once the information is collected from the fish, they are released.

In addition to research being conducted in the field, laboratory experiments are also conducted to answer important biological questions. The Kaskaskia Biological Station's wet lab houses several different fish species such as walleye (*Stizostedion vitreum*), bluegill (*Lepomis macrochirus*), largemouth bass (*Micropterus salmoides*), and muskellunge (*Esox masquinonge*) for laboratory experiments. The laboratory is equipped with a 40-tank recirculating system, several large stream tanks, and an environmental chamber in which temperature and light can be controlled. Experiments are currently being conducted in the wet lab to examine walleye feeding behavior to determine which food items and densities are best for growth and survival. This information will be used to determine which lakes will be best to stock young-of-year walleye.

Once all of the collections are made in the field and wet lab, the samples are returned to the main lab for processing, analysis, and reporting. Zooplankton, aquatic insects, and larval fish are all brought back to the lab for counting and identifying. Fish are aged by looking at scales and otoliths (ear bones in fish) under a microscope. After lab processing, these data are analyzed using statistics, written-up in reports to the Illinois DNR, and often published in professional journals to be used by people managing fish populations in the state and around the world.

Figure 11 Shoreline erosion and exposure of glacial till at Stop 2. Notice the slope of the beach. Geologists A. Phillips and M. Killey provide scale (photo by W. Frankie).

STOP 2 Quigley Cemetery – Wolf Creek State Park (NW SW NE, Sec. 18, T12N, R5E, 3rd PM, Shelby County, Middlesworth 7.5-Minute Quadrangle). Note: follow the path at the west end of the parking lot. The stop is located directly west of the cemetery along the shoreline of Lake Shelbyville.

Glacial History and Modern Coastal Processes

The lake bluffs at this stop offer excellent exposures of *diamicton* (poorly sorted clay, silt, sand, and gravel) that has been interpreted as *till*, sediment deposited by glacier ice without sorting by moving water (fig. 11). This till unit represents the Piatt Member of the Tiskilwa Formation, the basal formation of the Wedron Group (fig. 12). The Piatt was deposited during the Shelby Phase of the Michigan Subepisode, and has been dated to about 19,000 to 18,500 radiocarbon years ago (Hansel and Johnson 1992, Hansel and Johnson 1996).

The till is gray when fresh but weathers to light brown. It is relatively sandy, and in some exposures is interbedded with stratified sand. With time, larger particles have been concentrated at the bottom of the slope (you are standing on them) by erosion processes. You may be able to find stones and pebbles of a variety of compositions. Distinctive compositions indicate that some were carried by the glacier from as far away as northern Canada. As debris is moved within the ice, particles are reduced in size mainly by crushing. This action produces mainly angular particle shapes. However, the grinding together of debris within the glacier ice can also create smooth faces with parallel grooving.

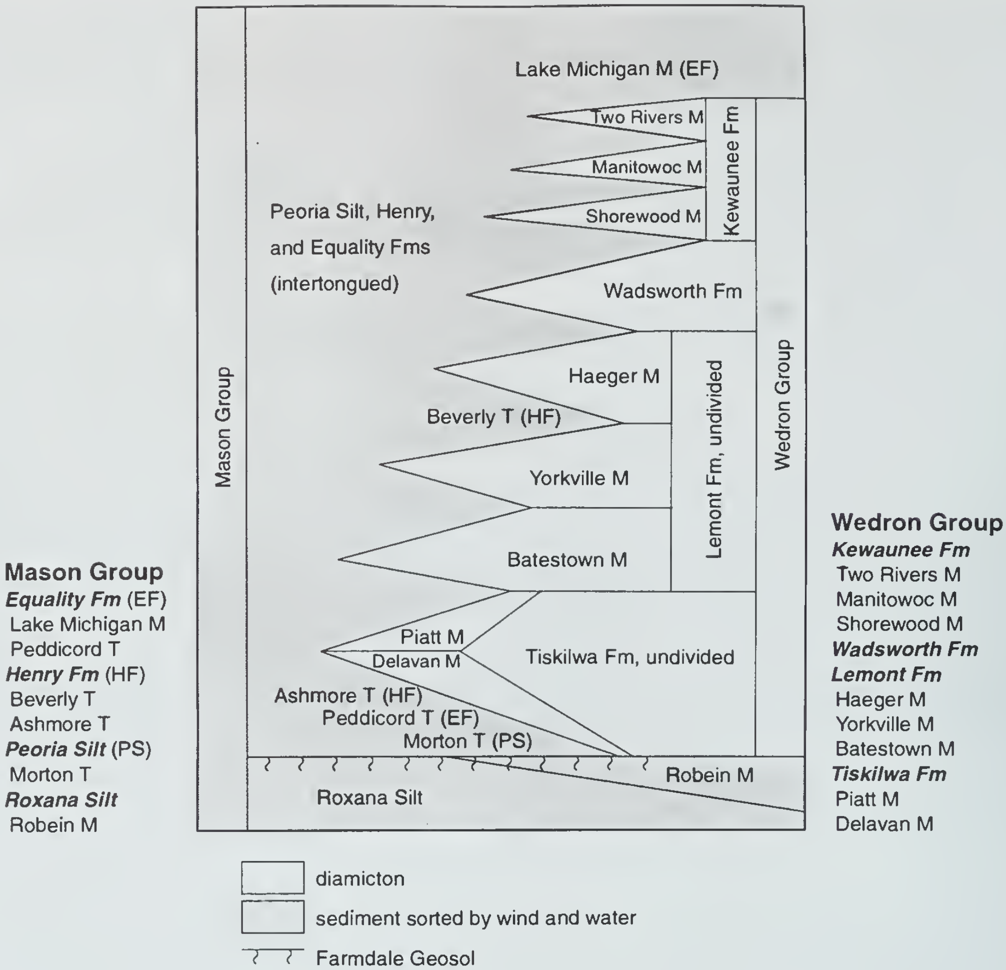


Figure 12 Stratigraphic relationships of the Mason and Wedron Group Units (modified from Hansel and Johnson 1996).

Shoreline Erosion

An interesting highlight at this stop is to observe the effects of shoreline erosion. The filling of reservoirs with sediment ("silting in") is a major concern in their maintenance. The sediment comes from erosion of reservoir shores by waves and sediment discharge by streams that feed the reservoir. Wave erosion occurs primarily, of course, when waves are big, that is, during storms.

The erosive power of waves is a function of their energy. Some of this energy can be dissipated by the shape of the shoreline. For example, where deep water meets a steep shoreline, waves will strike the shore unattenuated, that is, with maximum erosive power. By contrast, where the coast slopes gradually down into deeper water, erosive energy is dissipated over a larger area.

You can get some feel for the volume of eroded sediment by observing the present shape of the shoreline and conducting a thought experiment. The surrounding hillsides descend toward the lake but are truncated by a steep bluff, about 5 feet high. This bluff has been caused by wave erosion. By contrast, when the lake was first formed, the hillslope met the lake surface at a gentle angle. By following the slope of the hillsides down to the lake surface, you can imagine the original shoreline shape. When this guidebook was written, the shoreline had retreated about 35 feet (fig. 11). The

distance to the shoreline from the bluff and the bluff height (about 5 feet) formed the base and height of a triangle representing the cross-sectional area of shoreline removed by erosion. Multiplying this area (87.5 $feet^2$) by the length of the shoreline (172 miles or 908,160 feet) gives a total volume estimate of 79,464,000 ft^3 or 2,943,111 yd^3. This would fill 98,104 large dump trucks.

It seems that the caretakers of Quigley Cemetery were concerned about erosion, and so placed a line of large rocks at the base of the hillslope. The rock barrier did not prevent erosion, but did allow the relatively gently sloping "beach" upon which you are now standing to form. The rocks do dissipate some of the wave energy, and so coarse sediment (sand, gravel, cobbles) in the eroding bluffs is left behind as a lag, while finer sediment (silt and clay) is carried off into deeper water. This contrasts strongly with the steep bluffs and narrow beach that formed where there is no rock barrier.

We cannot see underwater, but the effects of the rock barrier on erosion there are nearly opposite the effects on subaerial landforms. Along the unprotected shoreline, sediment eroded off the bluffs is smeared out towards deeper water, creating a gentle slope. During storms, wave energy is thus dissipated gradually towards the shoreline by friction. By contrast, when waves strike the rock barrier, their energy is relatively high, causing erosion at the base of the rock barrier. Thus the lake bottom off the rock barrier is deeper and has a steeper slope than off the unprotected bluffs. With time, the rock barrier may become undercut enough that the rocks slide down into deeper water; then the cemetery would no longer be protected.

STOP 3 Lunch Stop: Lost Shelter Picnic Area – Wolf Creek State Park (NW NW NE, Sec. 25, T12N, R4E, 3rd PM, Shelby County, Middlesworth 7.5-Minute Quadrangle). "Are You Hungry?" The Lost Shelter Picnic Area is located at the southern end of Wolf Creek State Park, where Sand Creek flows into the Kaskaskia River.

GLACIATION

The Shelbyville area offers an excellent opportunity to observe the various types of land forms left by the glaciers of the most recent Wisconsin Episode. Within the field trip area, the Shelbyville Moraine forms the most conspicuous features on the landscape (see route maps and fig. 9).

After leaving Wolf Creek State Park, we will be heading east and then southward toward the Shelbyville Moraine. We will be following the same general direction as the Wisconsin Episode glacier that formed the moraine. The slope on the glacier (ice) side of the moraine is very small compared to the steeper slope on the front (outwash) side of the moraine.

Glacial Deposits

As a glacier melts, the soil and rocks that it had picked up as it advanced are released from the ice. Some of this material, called drift, is deposited in place as the ice melts. Such material consists of a thorough mixture of all kinds and sizes of rocks and is known as *till*. Some of the glacial drift is washed out (transported) by the melt waters. The coarsest of this water-transported *outwash* material is deposited near the ice-front, and progressively finer material is deposited farther away. Where the outwash material was spread widely in front of the glacier it formed an *outwash plain*, and where it was restricted to the river valleys, it formed terraces and elongate stringers of coarser deposits that are called *valley trains*.

At times, especially in the winter when melting slowed or stopped, the outwash plains and valley trains were exposed as the meltwater flow subsided. With little vegetation to hold it in place, the harsh, dry winter wind picked up silt and fine sand from these surfaces, blew the materials across the country, and dropped them to form the deposits known as *loess* that mantle most of Illinois. Near the larger river valleys, the loess may be as much as 60 to 80 feet thick. Far from the major valleys, including the area surrounding Shelbyville, it is measured only in inches.

Moraines

The position of the ice front at various times during each major advance of the glacier is usually marked by a ridge of till, or an end *moraine*. The end moraine consists mostly of the accumulation of drift that formed at the ice margin when the rates of forward flow and melting of the glacier were essentially in balance. As more and more material was carried forward to the edge of the ice, it melted out and piled up to form the end moraine. When melting exceeded the rate of advance, and the ice front retreated, the resulting drift deposits formed a *till plain*, whose surface may be almost level or slightly rolling.

The surface relief of end moraines, which is generally greater than that of the drift plains, is generally referred to as swell-and-swale or knob-and-kettle topography. At some places there are gaps in the end moraines where meltwater streams have presumably eroded away most of the drift. An example of this is the Kaskaskia River Valley, which has eroded through the Shelbyville Moraine.

Glacial Lakes

As the glaciers receded, meltwater commonly accumulated in local ponds or lakes between the ice front and the last formed moraine, except where there were channels through the moraine through which the water could drain. The Kaskaskia River provided an outlet for meltwater as the glacier receded from the Shelbyville Moraine. Where such drainage channels were absent, the local ponds and lakes gradually merged into one large lake that persisted until either the receding glaciers uncovered some outlet or the level of the water in the lake overtopped the confining moraine and formed a channel by erosion, through which the lake could be drained. Despite the fact that the Kaskaskia River drained most of the glacial meltwater, a small glacial lake did develop behind the Shelbyville Moraine, approximately 3 miles north of the village of Sullivan and halfway between the West Okaw River to the west and Jonathan Creek to the east.

STOP 4 Lake Shelbyville Dam – Spillway Access Area (SE SW, Sec. 8, T11N, R4E, 3rd PM, Shelby County, Shelbyville 7.5-Minute Quadrangle).

Lake Shelbyville Dam (fig. 13)

The lake was built by the U.S Army Corps of Engineers as part of a general comprehensive plan for the development of the Kaskaskia Basin for flood control, recreation, water supply, and fish and wildlife conservation.

The decision to place the dam here was, in part, based on geological information gathered during the planning stage. Some of this information includes the type of bedrock present, thickness of alluvium, and occurrence of mines, oil wells, pipelines, and other structural features. As you can imagine, a detailed geological analysis is an important part of any large-scale construction project.

Figure 13 Dam and Spillway at Lake Shelbyville – Stop 4 (photo by W. Frankie)

It was, of course, a monumental undertaking. Before actual work on the dam at Shelbyville could begin, several old mines in the area had to be completely filled in, cemeteries in the path of the planned lake had to be relocated, two gas and oil pipelines and roads rerouted, the old Shelby Power Plant demolished, and land cleared and leveled on the west side of the channel that hugs the bluff to the east of the river bottom. The mines that were encountered and filled in during construction of the dam were room and pillar mines with 10-foot-wide pillars and rooms measuring 30 by 40 feet. Construction of this $56 million project began in May 1963, and was completed in 1970.

At the normal summer pool level of 599.7 feet above sea level, the lake covers 11,100 surface acres of water. The lake has an average depth of 16 feet, with a maximum depth of 67 feet. Islands, coves, peninsulas, and inlets create 250 miles of forested shoreline.

The dam that forms Lake Shelbyville stands 110 feet above the original stream bed of the Kaskaskia Rriver. The dam is an earthen embankment 3,025 feet long with a reinforced-concrete, gate-controlled spillway to manipulate the water level and manage the 25,300 acres of its flood control pool.

In addition to the normal summer pool elevation of 599.7 feet above mean sea level (msl), which creates a 11,100 acre lake, the dam and corresponding reservoir was designed with a flood pool elevation of 626.5 feet above msl, which creates a 25,300 acre lake, and a winter pool elevation of 596 feet above msl, which corresponds to 9,793 acres. The storage capacity of the Lake Shelbyville reservoir is 210,000 acre feet of water at the summer pool elevation and 474,000 acre feet of water at the flood pool elevation. The dam has a crest elevation of 643 feet above msl.

Lake Shelbyville offers a multitude of fishing opportunities. Popular game species include catfish, crappie, largemouth bass, muskie, walleye, white bass, and bluegill. Approximately 12,000 acres of forested land surround Lake Shelbyville. Oak, hickory, and hard maple are the dominant species in the uplands, and cottonwood, sycamore, soft maple, and willow are the dominant species in the lowlands. Game species available for hunting include dove, quail, rabbit, pheasant, whitetail deer, grey and fox squirrel, fox, coyote, raccoon, woodcock, turkey, and waterfowl.

STOP 5 North Water Well Field (western half of the NW NE, Sec. 26, T11N, R3E, 3rd PM, Shelby County, Shelbyville and Fancher 7.5-Minute Quadrangles).

The city of Shelbyville's north water well field consists of three wells that are housed in small cinder-block buildings in a straight line perpendicular to and on the south side of the road. The city's south water well field is located 2 miles to the south along the Kaskaskia River in the western half of the SE SW, Sec. 35, T11N, R3E, on the Fancher 7.5-Minute Quadrangle (see route maps). The wells withdraw groundwater from water-bearing sand and gravel deposits associated with the Ancient Kaskaskia Bedrock Valley, as well as from alluvial deposits associated with the post-glaciation Kaskaskia River and one of its tributaries, Robinson Creek. The general nature of the deposits in the water field is illustrated by the stratigraphic log for Well No. 2 (fig. 14).

In recent years, there has been increased interest in this aquifer system and its potential for continued use as a viable and safe source of water. This increased awareness has resulted in an expressed desire by city officials to learn more about the resource and to be better able to address resource development and management plans. As part of Shelbyville's groundwater management plan, the city is working with the Illinois Environmental Protection Agency (IEPA) to reduce the amount of costly water-quality monitoring by identifying where the water comes from, what the potential sources of contamination are, and what steps to take to protect the aquifer. The best way to protect the aquifer is through land use control, and therefore the city has pursued the idea of purchasing some of the land around the well field.

The shallow aquifers in this area are very susceptible to contamination because the upper sands and gravels are close to the surface. At the north well field (fig. 14), there is 15 feet of silts and clays at the surface that provide protection for the aquifer because these fine materials can either absorb contaminants or slow them down enough that they have time to degrade. However, a sand and gravel pit located south of the north well field cuts through this protective layer and can provide a direct pathway for contaminants to reach the aquifer. Surface runoff and groundwater flowing into the pit flows to the south and away from the north well field. If new sand and gravel operations were established closer to or north of the well field, the quality and quantity of water produced by the wells could be impacted.

The south well field also has three wells, which are in a line going south from the Kaskaskia River. In this area, the river flows directly over the aquifer and has a significant impact on the quality and quantity of water flowing toward the wells. The aquifer is also covered by less than 5 feet of soil, which is insufficient to protect the aquifer from being contaminated by agricultural chemicals applied at the surface. A profile of the soil and the aquifer material can be seen along the bank of the river. The nitrate concentration in the water produced by the two wells farthest away from the river commonly exceeds by several milligrams per liter (mg/L) the maximum level set by the IEPA of 10 mg/L. The third well derives a much greater portion of its water from the river and consequently has a nitrate concentration similar to that of the river, which is generally well below the 10 mg/L standard. In order to use the water produced by this well field without issuing a public health warning, the city must blend it with water from the north well field, which has a lower nitrate concentration.

Kaskaskia River Valley

The Ancient Kaskaskia River Bedrock Valley was strongly influenced by the Pleistocene glaciers, which drastically altered the drainage and topography in the Shelbyville area. Before the onset of

		Thickness (feet)	Depth (feet)
PLEISTOCENE SERIES			
Soil, dark brown, silty, sandy		5	0–5
Silt, yellow-brown, sandy		5	5–10
Clay, light brown, silty, gravelly		5	10–15
Gravel, medium to coarse, clean		10	15–25
Gravel, fine to medium, clean		5	25–30
Gravel, medium to coarse	**upper**	5	30–35
Gravel, fine to coarse, sandy	**aquifer**	5	35–40
Sand, fine to coarse, gravelly, slightly silty	**lower**	5	40–45
Gravel, fine to coarse, very silty, sandy	**aquifer**	5	45–50
Sand, mostly medium to coarse, gravelly, clean		15	50–65

Screen from 42 to 57 feet; static water level is 18.5 feet; total depth is 65 feet

Figure 14 Log of Well No. 2 – Shelbyville North Water Well Field (NW NW NE, Sec. 26, T11N, R3E, Shelby County) (modified from Cartwright and Kraatz 1967).

the Pleistocene glaciation the Ancient Kaskaskia River drained the region through a broad valley cut into the Pennsylvanian bedrock (see figs. 15 and 16). The valley extended from northeast Shelby County southwestward through Fayette, Clinton, northwestern Washington, southern St. Clair, and Randolph Counties to the Ancient Mississippi River.

The Pre-Illinois Glacial Episodes did not significantly affect the valley, but during the Illinois and Wisconsin Glacial Episodes the valley was partially filled by glacial drift. Since then, the Kaskaskia River has re-excavated much of its former valley, but in northern Fayette and Shelby Counties it has abandoned the bedrock valley and cut a new valley farther east (see fig.15). The modern Kaskaskia River has also extended its valley about 50 miles farther north into Champaign County.

In the Shelbyville area, the old bedrock valley is filled with outwash and lies partially buried beneath Wisconsin and Illinois glacial tills. Locally the ancient bedrock valley passes directly beneath the city of Shelbyville toward the southwest (fig.15). The city's water supply is obtained from sands and gravels in this buried valley. Shelbyville's north water well field is located where the bedrock valley makes a bend southward. Robinson Creek flows along the old valley for about 2 miles to its junction with the present Kaskaskia River. Below the junction for about 2 more miles, the present Kaskaskia River has re-excavated part of the valley, and a widely swinging meander scar has been cut in the easily eroded valley fill.

The city of Shelbyville is situated at the base of a prominent extension of the Shelbyville Moraine. During Sangamonian time, between the Illinois and Wisconsin glacial episodes, the Kaskaskia River re-excavated part of its bedrock valley southwest from the city of Shelbyville. Later this valley influenced the local movement of the Shelbyville glacier, and a narrow tongue of ice extended down valley. While this tongue of ice blocked the valley, meltwater from the ice front began cutting the present Kaskaskia River Valley farther east. By the time the ice had melted, the new channel was established.

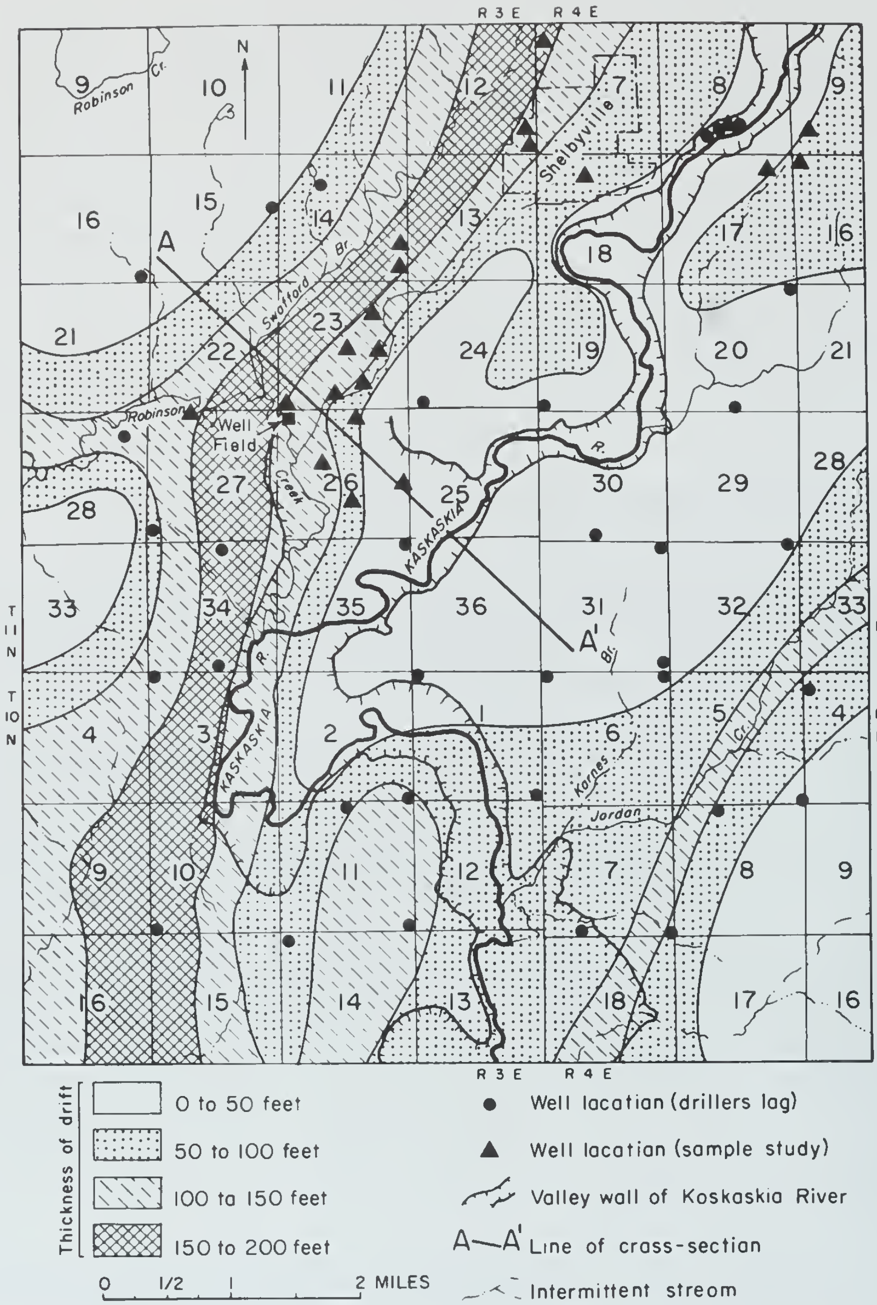


Figure 15 Thickness of glacial drift in the vicinity of Shelbyville, the 150 to 200 foot zone outlines the deepest part of the Ancient Kaskaskia River Bedrock Valley (modified from Cartwright and Kraatz 1967).

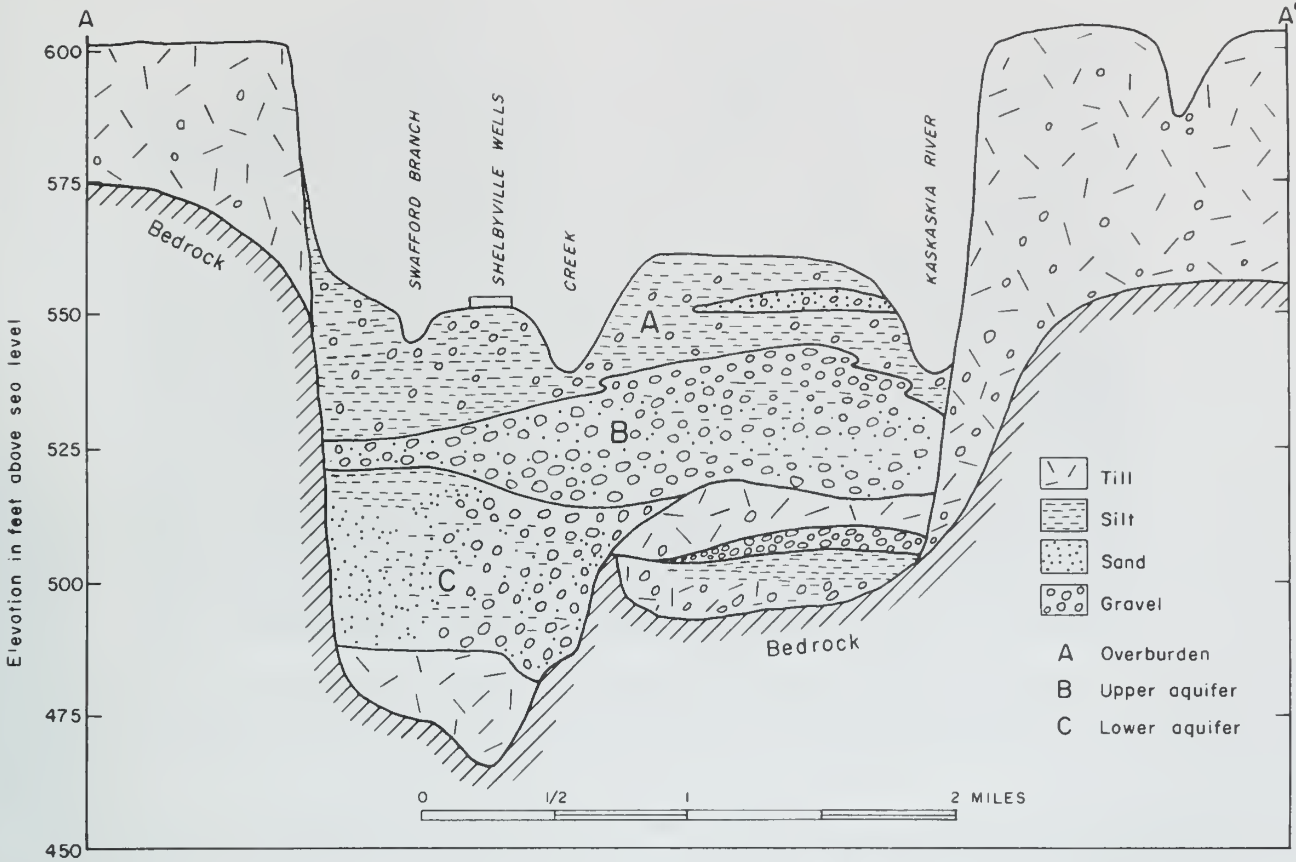


Figure 16 Generalized cross section of the Kaskaskia Valley Aquifer at Shelbyville, Illinois (modified from Cartwright and Kraatz 1967).

STOP 6 Prosser Sand and Gravel Pit (fig. 17) (SW SW, Sec. 25, T11N, R3E, 3rd PM, Shelby County, Fancher 7.5-Minute Quadrangle). This is known as the Hanfland pit after the original operator of the sand and gravel pits in the area. Several abandoned pits are located south of this pit (see route maps).

Glacial outwash deposits are an important source of commercial sand and gravel in Illinois. Production of sand and gravel in Illinois in 1992 was 35.7 million tons, with a combined value of $123.7 million.

The first commercial sand and gravel pit in this area was opened in 1948 by the Hanfland Sand and Gravel Company. The present pit is owned and operated by the Prosser Construction Company. Production averages 60,000 tons a year.

The overlying soils and clays are stripped off before mining. The sands and gravels are being mined with a combination of bulldozers, front-end loaders, and a dredging machine. The dredger is powered by a 400-horsepower Cummins engine, which provides the suction to lift the sands and gravels from the pit through a 12- to 30-foot-long pipe (fig. 17). The pipe starts out with a diameter of 10 inches and tapers down to 8 inches. They are currently mining to a depth of about 30 feet.

Figure 17 Dredging operation at the Prosser sand and gravel pit (photo by W. Frankie).

The sands and gravels are then sorted into various sizes in the processing plant. The finished products include three sizes of gravel, ⅝"–1", 1"– 1¾", 2"–4", and two sizes of sand (a fine masonry sand and a coarse sand). These products are generally sold to the local market.

Deposits along the Kaskaskia River consist of sands and gravels deposited by glacial meltwater that are assigned to the Mackinaw Member of the Henry Formation. They are overlain by reworked sands and gravels of the Cahokia Alluvium. These well-sorted sands and gravels were deposited when the glacier that formed the Shelbyville Moraine started to recede (melt). Since the sands and gravels become progressively finer to the south, we know that the stream that deposited them flowed toward the Mississippi River.

We are standing within the Kaskaskia River Valley. The modern valley is cut into Illinoian and younger glacier-derived sediments that, in turn, fill an older valley eroded into Upper Pennsylvanian bedrock. Portions of the present river course coincide with the bedrock valley. The drift covering the valley is as much as 150–200 feet thick (fig. 15). This mine is exploiting sands and gravels deposited by the glacier outwash streams.

Large volumes of water and sediment are discharged from glaciers when they melt. Typically, there is more sediment than the water can carry, so stream channels are formed, filled, and abandoned rapidly. This stream pattern of multiple, shallow, unstable channels is termed "braided." Unlike in other regions of Illinois where outwash plains (broad areas occupied by braided streams) occurred, this discharge was confined within the preexisting valley.

Modern examples of braided stream systems are common. It is through study of these modern streams that we can understand deposits left from ancient streams. Glacier outwash in Alaska is shown in Figure 18. The origin and geometry of deposits associated with a braided stream are shown in Figure 19.

Distinct layering, or stratification, is characteristic of sediments deposited by wind or water. Stratification results from the episodic nature of these flows. The aggregation of sediment into strata of gravel,

Figure 18 Riggs Glacier outwash delta in Glacier Bay, Alaska. A well-developed braided stream is in the middle of the view. Morainal deposits are in the lower left corner (photo by A. Phillips).

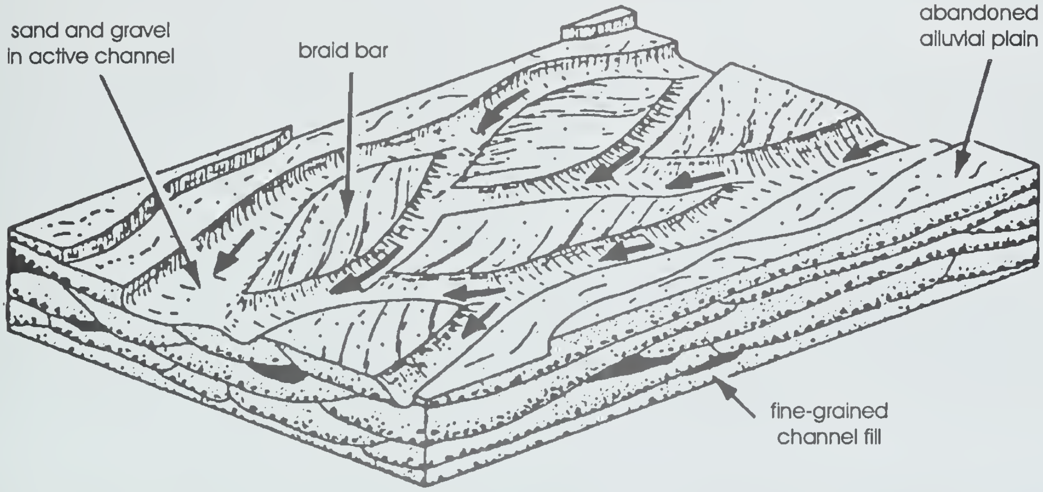


Figure 19 Diagram of alluvial environment and deposits associated with braided streams.

sand, silt, or clay arises from the ability of flowing water to selectively move particles of different sizes. Furthermore, sediment is temporarily stored in bars and ripples (generally, "bedforms") as it is transported downstream. The type of bedform and the manner in which it migrates is determined by sediment size (sand and gravel bedforms can have different overall shapes as well as internal structures), flow energy, and flow depth. By analyzing the stratification of these deposits, we can try to reconstruct what the original stream environment was like. In particular, flow direction and some

Figure 20 Braided stream deposits at Stop 6. Geologist A. Phillips provides scale (photo by W. Frankie).

estimate of flow energy can be determined from particle size and examination of the bedform and channel shape.

Examine the stratification (layering) in the sand and gravel. We know from the large size of the gravel that the streams must have been flowing swiftly. Structures that may be distinguishable include imbrication, graded bedding, parallel lamination, and cross-stratification. Imbrication occurs when particles become oriented by flowing water. It may be the alignment of individual large particles within a matrix of finer particles or the alignment of entire beds of gravel. As a channel is being abandoned, it will fill up with increasingly smaller sizes that reflect the waning flow; this is termed a "graded bed." Graded beds in which particle size increases from bottom to top reflect increasing flow energy. Parallel lamination in sands may indicate shallow, slow moving flows where bedforms were small or sparse. Cross-stratification of laminae or beds, on the other hand, is caused by migration of well-developed bedforms. When we visited this pit in preparation for the field trip, we could see the outline of an entire channel filled with rippled sands (fig. 20). Some eroded sections may allow 3-dimensional views of the bedforms. These 3-dimensional views allow determination of flow direction.

In addition to the large-scale structure of these sands and gravels, individual particles also reflect their history of transport and deposition. By contrast to the angular till pebbles at Stop 2, most particles here were worn relatively smooth after being discharged from the ice. Smoothness tends to increase with the duration of time in transport, so sediments farther downstream will be smoother (and smaller!) still.

SUPPLEMENTAL STOP 7 Copeland Bridge (SW NW NW, Sec. 30, T11N, R4E, 3rd PM, Shelby County, Fancher 7.5-Minute Quadrangle). Although we will not make this stop on today's field trip, the following descriptions have been included for those using this guidebook after today's excursion.

Pennsylvanian Bedrock – Mattoon Formation
Along the streams and rivers in the area where erosion has removed the glacial sediments, there are scattered exposures of the Upper Pennsylvanian Mattoon Formation. Thin limestones and coals are found, but clastic rocks (such as shales, siltstones, clays, and sandstones) predominate. Because of slumping and weathering of the Pennsylvanian bedrock as well as the thickness of glacial sediments, these exposures are often poor throughout the region.

Along the east side of the road and in the drainage ditch, immediately north of the Copeland Bridge, is an exposure of the thinly laminated (almost varved) siltstones to silty sandstone interval that typically overlies the Shelbyville Coal. These siltstones and silty sandstones are about all that is exposed nearly down to the river level, although older field notes report shales below this siltstone and sandstone. Just upstream in Sec. 19, T11N, R4E, field notes report exposures of the Shelbyville Coal along the banks of the Kaskaskia River.

Shelbyville Coal Member (Mattoon Formation)
The Shelbyville Coal Member (fig. 21) was referred to as the "Shelby coal" by G.C. Broadhead in his discussion on the geology of Shelby County (Worthen, 1875, p. 171). Worthen (1875, p. 2) included the Shelby coal in his general lithologic section; however, he used the term "Shelbyville seam" in discussing probable coal correlations (Worthen, 1875, p. 49). Kay (1915, p. 217) made clear that the term "Shelbyville" was preferred over "Shelby."

The type section of the Shelbyville Coal Member is designated by Nance and Treworgy (1981) as an exposure of the Mattoon Formation in a road ditch on the south side of Thompson Mill Bridge over the Kaskaskia River in Shelby County (near the center of the NE NW, Sec. 1, T9N, R3E) not too far south of the location of this field trip route and stops. This section is located approximately 10 miles south of the town of Shelbyville and about 2 miles southwest of the village of Fancher. The coal at the above locality is 26 inches thick and is overlain by a medium-gray limestone (weathered reddish brown) consisting dominantly of medium-grained crinoidal fragments and fairly abundant elongate coal detritus. Approximately 6 feet of limestone containing a 14-inch-thick shale split 4 feet above the base are exposed at this locality. The caprock limestone is lenticular in this area, and the coal is normally overlain by about 45 feet of silty shale or, in places, sandstone.

Cady (1952) expressed some doubt as to whether the coal exposed in the vicinity of Fancher correlates with the coal that was mined to the north near Shelbyville. However, the equivalence of these coals has been demonstrated by Bletier (1967) as well as by Nance and Treworgy (1981). In Shelby County, the Shelbyville Coal Member (fig. 21) normally lies between 125 and 150 feet above the Millersville Limestone Member, 60 feet above the Oconee Coal Member, and about 75 feet below the Omega Limestone Member.

The Shelbyville Coal is exposed and has been mined from many shallow shafts, drifts, and small pits along the tributaries and northeast-trending valleys of Mud and Robinson Creeks in an area between the towns of Shelbyville and Tower Hill. The coal is also exposed and has been mined along the

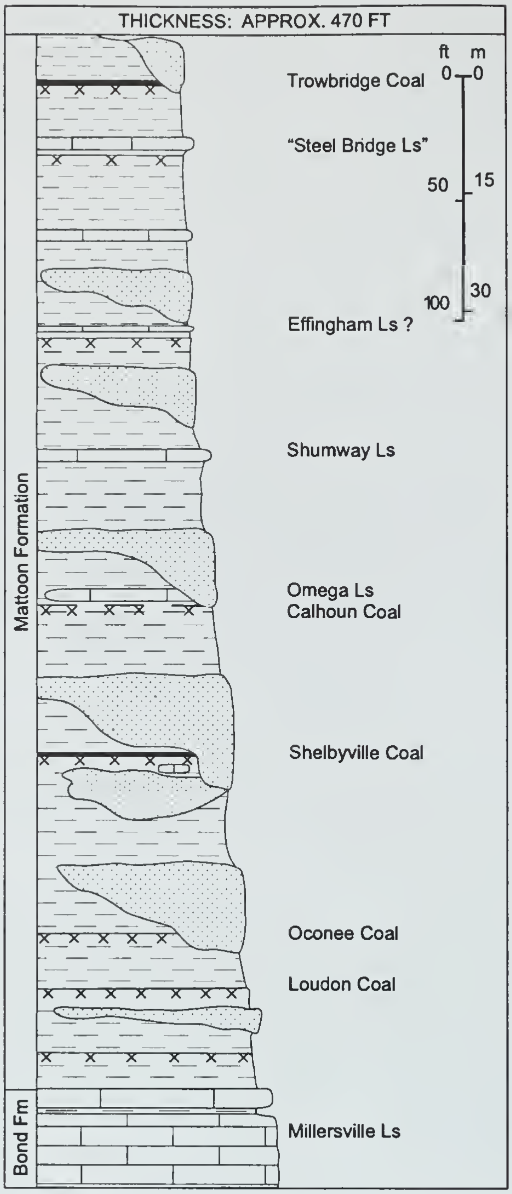


Figure 21 Generalized stratigraphic column of Pennsylvanian rocks in the field trip area (modified from Nance and Treworgy 1981).

Kaskaskia River and its tributaries from about 2 miles northeast of Shelbyville to approximately 1 mile north of the southern boundary of Shelby County.

In Shelby County, the Shelbyville Coal dips generally to the east and is overlain by 50 to 150 feet of surficial glacial deposits north of the Wisconsinan glacial boundary in the northern portion of the county. The coal is truncated to the west by a northwest–southeast-trending glacial-sediment-filled valley that extends from the town of Tower Hill (8 miles west of Shelbyville) to the town of Cowden, approximately 2 miles west of the type section (fig. 22).

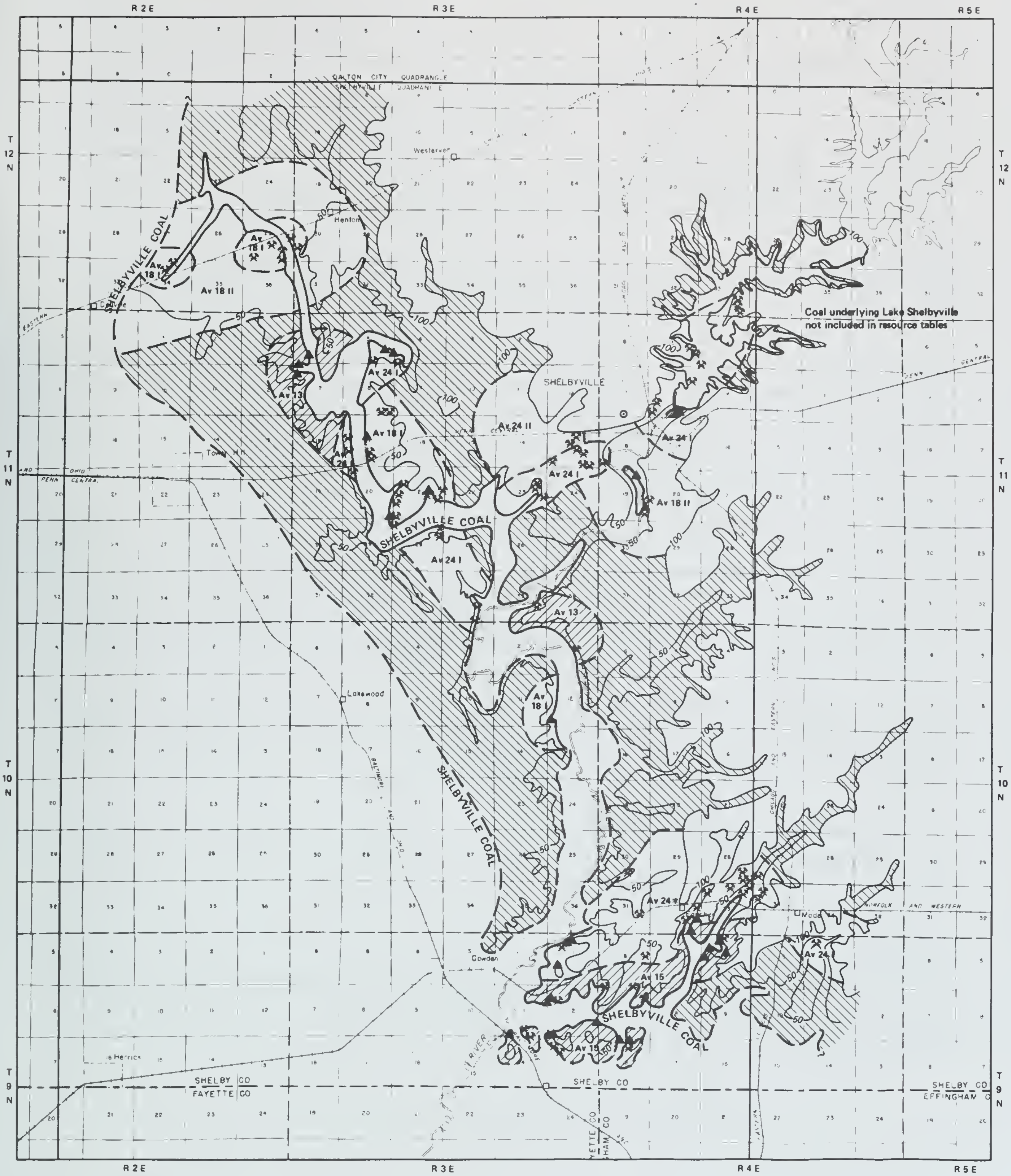


Figure 22 Map showing distribution of the Shelbyville Coal.

The Shelbyville Coal varies in thickness from about 16 to 26 inches and averages about 20 inches in the areas where it is exposed and has been mined in Shelby County. The coal is normally overlain by 40 to 50 feet of silty shale and/or sandstone (such as the exposure near Copeland Bridge), with the sandstone generally better developed to the north in the area of Shelbyville (Bleuer 1967). In places, the Shelbyville Coal may be overlain by a black shale up to 3 feet thick, which has been noted in a few exposures and mines along the east side of Mud Creek and in the southern portion of Robinson Creek. As at its type section, the Shelbyville Coal may be overlain by a lenticular crinoidal limestone up to 6 feet thick. This limestone was observed to have a maximum thickness of about 5 feet and a lateral continuity of approximately 100 feet in a northeast–southwest direction in an excavation pit in Shelby County for the Lake Shelbyville Dam spillway (NE SE SW, Sec. 8, T11 N, R4E).

In Shelby County, approximately 4 miles south of Shelbyville (along the northern boundary of Sec. 6, T10N, R4E) and to the west (in the south half of Sec. 34 and 35, T11N, R3E) a 25-foot limestone lying approximately 3 to 6 feet above the Shelbyville Coal is exposed. This limestone is apparently present in an east–west band probably no more than 1 mile wide and may, as suggested by Bleuer (1967), have been deposited in a topographic low, as the interval between the Millersville Limestone and the Shelbyville Coal decreases to about 25 feet in this area. The argillaceous, cherty limestone contains shale beds and has marine shell fragments in the basal 2 to 5 feet. Northwest of this area, a similar limestone up to 30 feet thick is exposed west of Robinson Creek in the southwest portion of T11N, R3E, Shelby County, and between the town of Tower Hill and Mud Creek in the northeastern portion of T11N, R2E, Shelby County. This limestone crops out in a narrow band trending northwest–southeast and may be an extension of the previous east–west trend; however, in an area approximately 2 miles northeast of Tower Hill, this limestone is underlain by up to 35 feet of sandstone, and it is not known whether the Shelbyville Coal is present below this sandstone or whether it has been removed by erosion and replaced by the sandstone. This relatively thick limestone is thought to be older than the uppermost shale and sandstone present above the Shelbyville Coal in the vicinity of Shelbyville and, as suggested by Bleuer (1967), may, in part, be older than the crinoidal caprock limestone.

A total of 68,636,000 tons of strippable resources (Nance and Treworgy 1981) has been estimated within the mapped areas of the Shelbyville Coal in Effingham, Fayette, and Shelby Counties. Of that total, nearly 66,912,000 tons were estimated for Shelby County alone. Coal resources amounting to 5,161,000 tons underlying 2.5 square miles of Lake Shelbyville were excluded.

The Shelbyville Coal was locally mined in the past along the Kaskaskia River Valley in small underground drift, slope, and shaft mines, as well as in small surface pits. A quick examination of Figure 22 shows the many small mines that operated along the Kaskaskia Valley and its tributaries in the past. Most of these mines operated in the 1920s to late 1940s, with the most recent mine reported as a small surface mine in the early to mid-1950s. When construction of the dam was undertaken, several of these small mines and coal shafts from the late 1930s to early 1940s were found and filled in prior to construction. The amount of actual mining was probably small, and Nance and Treworgy (1981) did not consider it significant enough even to report a figure on how much of the estimated resources were mined out.

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GLOSSARY

The following definitions are adapted in total or in part from several sources; the principal source is R.L. Bates and J.A Jackson, eds.,Glossary of Geology, 3rd ed.: American Geological Institute, Alexandria, VA, 1987, 788 p.

Ablation - Separation and removal of rock material and formation of deposits, especially by wind action or the washing away of loose and soluble materials.

Age - An interval of geologic time; a division of an epoch.

Aggrading stream - One that is actively depositing sediment in its channel or floodplain because it is being supplied with more load than it can transport.

Alluviated valley - One that has been at least partially filled with sand, silt, and mud by flowing water.

Alluvium - A general term for clay, silt, sand, gravel, or similar unconsolidated sorted or semisorted sediment deposited during comparatively recent time by a stream or other body of running water.

Anticline - A convex-upward rock fold in which strata have been bent into an arch; the strata on either side of the core of the arch are inclined in opposite directions away from the axis or crest; the core contains older rocks than does the perimeter of the structure.

Aquifer - A geologic formation that is water-bearing and which transmits water from one point to another.

Argillaceous - Said of rock or sediment that contains, or is composed of, clay-sized particles or clay minerals.

Arenite - A relatively clean quartz sandstone that is well sorted and contains less than 10% argillaceous material.

Base level - Lower limit of erosion of the land's surface by running water. Controlled locally and temporarily by the water level of stream mouths emptying into lakes, or more generally and semipermanently by the level of the ocean (mean sea level).

Basement complex - The suite of mostly crystalline igneous and/or metamorphic rocks that generally underlies the sedimentary rock sequence.

Basin - A topographic or structural low area that generally receives thicker deposits of sediments than adjacent areas; the low areas tend to sink more readily, partly because of the weight of the thicker sediments; the term also denotes an area of relatively deep water adjacent to shallow-water shelf areas.

Bed - A naturally occurring layer of earth material of relatively greater horizontal than vertical extent that is characterized by physical properties different from those of overlying and underlying materials. It also is the ground upon which any body of water rests or has rested, or the land covered by the waters of a stream, lake, or ocean; the bottom of a stream channel.

Bedrock - The solid rock (sedimentary, igneous, or metamorphic) that underlies the unconsolidated (non-indurated) surface materials (for example, soil, sand, gravel, glacial till, etc.).

Bedrock valley - A drainageway eroded into the solid bedrock beneath the surface materials. It may be completely filled with unconsolidated (non-indurated) materials and hidden from view.

Braided stream - A low-gradient, low-volume stream flowing through an intricate network of interlacing shallow channels that repeatedly merge and divide, and are separated from each other by branch islands or channel bars. Such a stream may be incapable of carrying all of its load. Most streams that receive more sediment load than they can carry become braided.

Calcarenite - Describes a limestone composed of more or less worn fragments of shells or pieces of older limestone. The particles are generally sand-sized.

Calcareous - Said of a rock containing some calcium carbonate ($CaCO_3$), but composed mostly of something else; (synonym: limey).

Calcining - The heating of calcite or limestone to its temperature of dissociation so that it loses its carbon dioxide; also applied to the heating of gypsum to drive off its water of crystallization to make plaster of paris.

Calcite - A common rock-forming mineral consisting of $CaCO_3$; it may be white, colorless, or pale shades of gray, yellow, and blue; it has perfect rhombohedral cleavage, appears vitreous, and has a hardness of 3 on the Mohs scale; it effervesces (fizzes) readily in cold dilute hydrochloric acid. It is the principal constituent of limestone.

Chert - Silicon dioxide (SiO_2); a compact, massive rock composed of minute particles of quartz and/or chalcedony; it is similar to flint, but lighter in color.

Clastic - Said of rocks composed of particles of other rocks or minerals, including broken organic hard parts as well as rock substances of any sort, transported and deposited by wind, water, ice or gravity.

Closure - The difference in altitude between the crest of a dome or anticline and the lowest structural or elevation contour that completely surrounds it.

Columnar section - A graphic representation, in the form of one or more vertical column(s), of the vertical succession and stratigraphic relations of rock units in a region.

Conformable - Said of strata deposited one upon another without interruption in accumulation of sediment; beds parallel.

Delta - A low, nearly flat, alluvial land form deposited at or near the mouth of a river where it enters a body of standing water; commonly a triangular or fan-shaped plain extending beyond the general trend of a coastline.

Detritus - Loose rock and mineral material produced by mechanical disintegration and removed from its place of origin by wind, water, gravity, or ice; also, fine particles of organic matter, such as plant debris.

Disconformity - An *unconformity* marked by a distinct erosion-produced irregular, uneven surface of appreciable relief between parallel strata below and above the break; sometimes represents a considerable time interval of nondeposition.

Dolomite - A mineral, calcium-magnesium carbonate ($Ca,Mg[CO_3]_2$); also the name applied to sedimentary rocks composed largely of the mineral. It is white, colorless, or tinged yellow, brown, pink, or gray; has perfect rhombohedral cleavage; appears pearly to vitreous; effervesces feebly in cold dilute hydrochloric acid.

Drift - All rock material transported by a glacier and deposited either directly by the ice or reworked and deposited by meltwater streams and/or the wind.

Driftless Area - A 10,000-square-mile area in northeastern Iowa, southwestern Wisconsin, and northwestern Illinois where the absence of glacial drift suggests that the area may not have been glaciated.

End moraine - A ridge or series of ridges formed by accumulations of drift built up along the outer margin of an actively flowing glacier at any given time; a moraine that has been deposited at the lower or outer end of a glacier.

Epoch - An interval of geologic time; a division of a period. (Example: Pleistocene Epoch).

Era - The unit of geologic time that is next in magnitude beneath an eon; it consists of two or more periods. (Example: Paleozoic Era).

Escarpment - A long, more or less continuous cliff or steep slope facing in one general direction; it generally marks the outcrop of a resistant layer of rocks, or the exposed plane of a fault that has moved recently.

Fault - A fracture surface or zone of fractures in Earth materials along which there has been vertical and/or horizontal displacement or movement of the strata on opposite sides relative to one another.

Flaggy - Said of rock that tends to split into layers of suitable thickness for use as flagstone.

Flood plain - The surface or strip of relatively smooth land adjacent to a stream channel produced by the stream's erosion and deposition actions; the area covered with water when the stream overflows its banks at times of high water; it is built of alluvium carried by the stream during floods and deposited in the sluggish water beyond the influence of the swiftest current.

Fluvial - Of or pertaining to a river or rivers.

Formation - The basic rock unit, one distinctive enough to be readily recognizable in the field and widespread and thick enough to be plotted on a map. It describes the strata, such as limestone, sandstone, shale, or combinations of these and other rock types. Formations have formal names, such as Joliet Formation or St. Louis Limestone (Formation), generally derived from the geographic localities where the unit was first recognized and described.

Fossil - Any remains or traces of a once-living plant or animal preserved in rocks (arbitrarily excludes Recent remains); any evidence of ancient life. Also used to refer to any object that existed in the geologic past and for which evidence remains (for example, a fossil waterfall)

Friable - Said of a rock or mineral that crumbles naturally or is easily broken, pulverized, or reduced to powder, such as a soft and poorly cemmented sandstone.

Geology - The study of the planet Earth that is concerned with its origin, composition, and form, its evolution and history, and the processes that acted (and act) upon it to control its historic and present forms.

Geophysics - Study of the Earth with quantitative physical methods. Application of the principles of physics to the study of the earth, especially its interior.

Glaciation - A collective term for the geologic processes of glacial activity, including erosion and deposition, and the resulting effects of such action on the Earth's surface.

Glacier - A large, slow-moving mass of ice formed on land by the compaction and recrystallization of snow.

Gradient - A part of a surface feature of the Earth that slopes upward or downward; the angle of slope, as of a stream channel or of a land surface, generally expressed by a ratio of height versus distance, a percentage or an angular measure from the horizontal.

Igneous - Said of a rock or mineral that solidified from molten or partly molten material (that is, from magma).

Indurated - Said of compact rock or soil hardened by the action of pressure, cementation and, especially, heat.

Joint - A fracture or crack in rocks along which there has been no movement of the opposing sides (see also *Fault*).

Karst - Collective term for the land forms and subterranean features found in areas with relatively thin soils underlain by limestone or other soluble rocks; characterized by many sinkholes separated by steep ridges or irregular hills. Tunnels and caves formed by dissolution of the bedrock by groundwater honeycomb the subsurface. Named for the region around Karst in the Dinaric Alps of Croatia where such features were first recognized and described.

Lacustrine - Produced by or belonging to a lake.

Laurasia - A protocontinent of the Northern Hemisphere, corresponding to Gondwana in the Southern Hemisphere, from which the present continents of the Northern Hemisphere have been derived by separation and continental displacement. The supercontinent from which both were derived is Pangea. Laurasia included most of North America, Greenland, and most of Eurasia, excluding India. The main zone of separation was in the North Atlantic, with a branch in Hudson Bay; geologic features on opposite sides of these zones are very similar.

Lava - Molten, fluid rock that is extruded onto the surface of the Earth through a volcano or fissure. Also the solid rock formed when the lava has cooled.

Limestone - A sedimentary rock consisting primarily of calcium carbonate (the mineral, calcite). Limestone is generally formed by accumulation, mostly in place or with only short transport, of the shells of marine animals, but it may also form by direct chemical precipitation from solution in hot springs or caves and, in some instances, in the ocean.

Lithify - To change to stone, or to petrify; especially to consolidate from a loose sediment to a solid rock.

Lithology - The description of rocks on the basis of their color, structure, mineral composition, and grain size; the physical character of a rock.

Local relief - The vertical difference in elevation between the highest and lowest points of a land surface within a specified horizontal distance or in a limited area.

Loess - A homogeneous, unstratified accumulation of silt-sized material deposited by the wind.

Magma - Naturally occurring molten rock material generated within Earth and capable of intrusion into surrounding rocks or extrusion onto the Earth's surface. When extruded on the surface it is called lava. The material from which igneous rocks form through cooling, crystallization, and related processes.

Meander - One of a series of somewhat regular, sharp, sinuous curves, bends, loops, or turns produced by a stream, particularly in its lower course where it swings from side to side across its valley bottom.

Meander scars - Crescent-shaped swales and gentle ridges along a river's flood plain that mark the positions of abandoned parts of a meandering river's channel. They are generally filled in with sediments and vegetation and are most easily seen in aerial photographs.

Metamorphic rock - Any rock derived from pre-existing rocks by mineralogical, chemical, and structural changes, essentially in the solid state, in response to marked changes in temperature, pressure, shearing stress, and chemical environment at depth in Earth's crust (for example, gneisses, schists, marbles, quartzites, etc.)

Mineral - A naturally formed chemical element or compound having a definite chemical composition, an ordered internal arrangement of its atoms, and characteristic crystal form and physical properties.

Monolith - (a) A piece of unfractured bedrock, generally more than a few meters across. (b) A large upstanding mass of rock.

Moraine - A mound, ridge, or other distinct accumulation of glacial drift, predominantly till, deposited in a variety of topographic land forms that are independent of control by the surface on which the drift lies (see also *End Moraine*).

Morphology - The scientific study of form, and of the structures and development that influence form; term used in most sciences.

Natural gamma log - One of several kinds of measurements of rock characteristics taken by lowering instruments into cased or uncased, air- or water-filled boreholes. Elevated natural gamma radiation levels in a rock generally indicate the presence of clay minerals.

Nickpoint - A place with an abrupt inflection in a stream profile, generally formed by the presence of a rock layer resistant to erosion; also, a sharp angle cut by currents at base of a cliff.

Nonconformity - An unconformity resulting from deposition of sedimentary strata on massive crystalline rock.

Outwash - Stratified glacially derived sediment (clay, silt, sand, gravel) deposited by meltwater streams in channels, deltas, outwash plains, on flood plains, and in glacial lakes.

Outwash plain - The surface of a broad body of outwash formed in front of a glacier.

Oxbow lake - A crescent-shaped lake in an abandoned bend of a river channel. A precursor of a meander scar.

Pangea - The supercontinent that existed from 300 to 200 million years ago. It combined most of the continental crust of the Earth, from which the present continents were derived by fragmentation and movement away from each other by means of plate tectonics. During an intermediate stage of the fragmentation, between the existence of Pangea and that of the present widely separated continents, Pangea was split into two large fragments, *Laurasia* on the north and *Gondwana* in the southern hemisphere.

Ped - Any naturally formed unit of soil structure (for example, granule, block, crumb, or aggregate).

Peneplain - A land surface of regional scope worn down by erosion to a nearly flat or broadly undulating plain.

Period - An interval of geologic time; a division of an era (for example, Cambrian, Jurassic, Tertiary).

Physiography - The study and classification of the surface features of Earth on the basis of similarities in geologic strucure and the history of geologic changes.

Physiographic province (or division) - (a) A region, all parts of which are similar in geologic structure and climate and which has consequently had a unified geologic history. (b) Aa region whose pattern of relief features or landforms differs significantly from that of adjacent regions.

Point bar - A low arcuate ridge of sand and gravel developed on the inside of a stream meander by accumulation of sediment as the stream channel migrates toward the outer bank.

Radioactivity logs - Any of several types of geophysical measurements taken in bore holes using either the natural radioactivity in the rocks, or the effects of radiation on the rocks to determine the lithology or other characteristics of the rocks in the walls of the borehole. (Examples: natural gamma radiation log; neutron density log).

Relief - (a) A term used loosely for the actual physical shape, configuration, or general uneveness of a part of Earth's surface, considered with reference to variations of height and slope or to irregularities of the land surface; the elevations or differences in elevation, considered collectively, of a land surface (frequently confused with topography). (b) The vertical difference in elevation between the hilltops or mountain summits and the lowlands or valleys of a given region; "high relief" has great variation; "low relief" has little variation.

Rift - A long narrow trough, generally on a continent, bounded by normal faults, a graben with regional extent. Formed in places where the forces of plate tectonics are beginning to split a continent. (Example: East African Rift Valley).

Sediment - Solid fragmental matter, either inorganic or organic, that originates from weathering of rocks and is transported and deposited by air, water, or ice, or that is accumulated by other natural agents, such as chemical precipitation from solution or secretion from organisms. When deposited, it generally forms layers of loose, unconsolidated material (for example, sand, gravel, silt, mud, till, loess, alluvium).

Sedimentary rock - A rock resulting from the consolidation of loose sediment that has accumulated in layers (for example, sandstone, siltstone, mudstone, limestone).

Shoaling - Said of an ocean or lake bottom that becomes progressively shallower as a shoreline is approached. The shoaling of the ocean bottom causes waves to rise in height and break as they approach the shore.

Sinkhole - Any closed depression in the land surface formed as a result of the collapse of the underlying soil or bedrock into a cavity. Sinkholes are common in areas where bedrock is near the surface and susceptible to dissolution by infiltrating surface water. Sinkhole is synonymous with "doline," a term used extensively in Europe. The essential component of a hydrologically active sinkhole is a drain that allows any water that flows into the sinkhole to flow out the bottom into an underground conduit.

Slip-off slope - Long, low, gentle slope on the inside of a stream meander. The slope on which the sand that forms point bars is deposited.

Stage, substage - Geologic time-rock units; the strata formed during an age or subage, respectively. Generally applied to glacial episodes (for example, to the Woodfordian Substage of the Wisconsinan Stage.

Stratigraphy - The study, definition, and description of major and minor natural divisions of rocks, particularly the study of their form, arrangement, geographic distribution, chronologic succession, naming or classification, correlation, and mutual relationships of rock strata.

Stratigraphic unit - A stratum or body of strata recognized as a unit in the classification of the rocks of Earth's crust with respect to any specific rock character, property, or attribute or for any purpose such as description, mapping, and correlation.

Stratum - A tabular or sheet-like mass, or a single, distinct layer of material of any thickness, separable from other layers above and below by a discrete change in character of the material or by a sharp physical break, or by both. The term is generally applied to sedimentary rocks, but could be applied to any tabular body of rock. (See also *Bed*)

Subage - A small interval of geologic time; a division of an age.

Syncline - A convex-downward fold in which the strata have been bent to form a trough; the strat on either side of the core of the trough are inclined in opposite directions toward the axis of the fold; the core area of the fold contains the youngest rocks. (See also *Anticline*).

System - A fundamental geologic time-rock unit of worldwide significance; the strata of a system are those deposited during a period of geologic time (for example, rocks formed during the Pennsylvanian Period are included in the Pennsylvanian System).

Tectonic - Pertaining to the global forces that cause folding and faulting of the Earth's crust. Also used to classify or describe features or structures formed by the action of those forces.

Tectonics - The branch of geology dealing with the broad architecture of the upper (outer) part of Earth; that is, the major structural or deformational features, their origins, historical evolution, and relations to each other. It is similar to structural geology, but generally deals with larger features such as whole mountain ranges, or continents.

Temperature-resistance log - A borehole log, run only in water-filled boreholes, that measures the water temperature and the quality of groundwater in the well.

Terrace - An abandoned floodplain formed when a stream flowed at a level above the level of its present channel and floodplain.

Till - Unlithified, nonsorted, unstratified drift deposited by and underneath a glacier and consisting of a heterogenous mixture of different sizes and kinds of rock fragments.

Till plain - The undulating surface of low relief in an area underlain by ground moraine.

Topography - The natural or physical surface features of a region, considered collectively as to form; the features revealed by the contour lines of a map.

Unconformable - Said of strata that do not succeed the underlying rocks in immediate order of age or in parallel position. A general term applied to any strata deposited directly upon older rocks after an interruption in sedimentation, with or without any deformation and/or erosion of the older rocks.

Unconformity - A surface of erosion or nondeposition that separates younger strata from older strata; most unconformities indicate intervals of time when former areas of the sea bottom were temporarily raised above sea level.

Valley trains - The accumulations of outwash deposited by rivers in their valleys downstream from a glacier.

Water table - The point in a well or opening in the Earth where groundwater begins. It generally marks the top of the zone where the pores in the surrounding rocks are fully saturated with water.

Weathering - The group of processes, both chemical and physical, whereby rocks on exposure to the weather change in character, decay, and finally crumble into soil.

PLEISTOCENE GLACIATIONS IN ILLINOIS

Origin of the Glaciers

During the past million years or so, an interval of time called the Pleistocene Epoch, most of the northern hemisphere above the 50th parallel has been repeatedly covered by glacial ice. The cooling of the earth's surface, a prerequisite for glaciation, began at least 2 million years ago. On the basis of evidence found in subpolar oceans of the world (temperature-dependent fossils and oxygen-isotope ratios), a recent proposal has been made to recognize the beginning of the Pleistocene at 1.6 million years ago. Ice sheets formed in sub-arctic regions many times and spread outward until they covered the northern parts of Europe and North America. In North America, early studies of the glacial deposits led to the model that four glaciations could explain the observed distribution of glacial deposits. The deposits of a glaciation were separated from each other by the evidence of intervals of time during which soils formed on the land surface. In order of occurrence from the oldest to the youngest, they were given the names Nebraskan, Kansan, Illinoian, and Wisconsinan Stages of the Pleistocene Epoch. Work in the last 30 years has shown that there were more than four glaciations but the actual number and correlations at this time are not known. Estimates that are gaining credibility suggest that there may have been about 14 glaciations in the last one million years. In Illinois, estimates range from 4 to 8 based on buried soils and glacial deposits. For practical purposes, the previous four glacial stage model is functional, but we now know that the older stages are complex and probably contain more than one glaciation. Until we know more, all of the older glacial deposits, including the Nebraskan and Kansan will be classified as pre-Illinoian. The limits and times of the ice movement in Illinois are illustrated in the following pages by several figures.

The North American ice sheets developed when the mean annual temperature was perhaps 4° to 7°C (7° to 13°F) cooler than it is now and winter snows did not completely melt during the summers. Because the time of cooler conditions lasted tens of thousands of years, thick masses of snow and ice accumulated to form glaciers. As the ice thickened, the great weight of the ice and snow caused them to flow outward at their margins, often for hundreds of miles. As the ice sheets expanded, the areas in which snow accumulated probably also increased in extent.

Tongues of ice, called lobes, flowed southward from the Canadian centers near Hudson Bay and converged in the central lowland between the Appalachian and Rocky Mountains. There the glaciers made their farthest advances to the south. The sketch below shows several centers of flow, the general directions of flow from the centers, and the southern extent of glaciation. Because Illinois lies entirely in the central lowland, it has been invaded by glaciers from every center.

Effects of Glaciation

Pleistocene glaciers and the waters melting from them changed the landscapes they covered. The glaciers scraped and smeared the landforms they overrode, leveling and filling many of the minor valleys and even some of the larger ones. Moving ice carried colossal amounts of rock and earth, for much of what the glaciers wore off the ground was kneaded into the moving ice and carried along, often for hundreds of miles.

The continual floods released by melting ice entrenched new drainageways, deepened old ones, and then partly refilled both with sediments as great quantities of rock and earth were carried beyond the glacier fronts. According to some estimates, the amount of water drawn from the sea and changed into ice during a glaciation was enough to lower the sea level from 300 to 400 feet below present level. Consequently, the melting of a continental ice sheet provided a tremendous volume of water that eroded and transported sediments.

In most of Illinois, then, glacial and meltwater deposits buried the old rock-ribbed, low, hill-and-valley terrain and created the flatter landforms of our prairies. The mantle of soil material and the buried deposits of gravel, sand, and clay left by the glaciers over about 90 percent of the state have been of incalculable value to Illinois residents.

Glacial Deposits

The deposits of earth and rock materials moved by a glacier and deposited in the area once covered by the glacier are collectively called **drift**. Drift that is ice-laid is called **till**. Water-laid drift is called **outwash**.

Till is deposited when a glacier melts and the rock material it carries is dropped. Because this sediment is not moved much by water, a till is unsorted, containing particles of different sizes and compositions. It is also stratified (unlayered). A till may contain materials ranging in size from microscopic clay particles to large boulders. Most tills in Illinois are pebbly clays with only a few boulders. For descriptive purposes, a mixture of clay, silt, sand and boulders is called **diamicton**. This is a term used to describe a deposit that could be interpreted as till or a mass wasting product.

Tills may be deposited as **end moraines**, the arc-shaped ridges that pile up along the glacier edges where the flowing ice is melting as fast as it moves forward. Till also may be deposited as **ground moraines**, or **till plains**, which are gently undulating sheets deposited when the ice front melts back, or retreats. Deposits of till identify areas once covered by glaciers. Northeastern Illinois has many alternating ridges and plains, which are the succession of end moraines and till plains deposited by the Wisconsinan glacier.

Sorted and stratified sediment deposited by water melting from the glacier is called **outwash**. Outwash is bedded, or layered, because the flow of water that deposited it varied in gradient, volume, velocity, and direction. As a meltwater stream washes the rock materials along, it sorts them by size—the fine sands, silts, and clays are carried farther downstream than the coarser gravels and cobbles. Typical Pleistocene outwash in Illinois is in multilayered beds of clays, silts, sands, and gravels that look much like modern stream deposits in some places. In general, outwash tends to be coarser and less weathered, and alluvium is most often finer than medium sand and contains variable amounts of weathered material.

Outwash deposits are found not only in the area covered by the ice field but sometimes far beyond it. Meltwater streams ran off the top of the glacier, in crevices in the ice, and under the ice. In some places, the cobble-gravel-sand filling of the bed of a stream that flowed in the ice is preserved as a sinuous ridge called an **esker**. Some eskers in Illinois are made up of sandy to silty deposits and contain mass wasted diamicton material. Cone-shaped mounds of coarse outwash, called **kames**, were formed where meltwater plunged through crevasses in the ice or into ponds on the glacier.

The finest outwash sediments, the clays and silts, formed bedded deposits in the ponds and lakes that filled glacier-dammed stream valleys, the sags of the till plains, and some low, moraine-diked till plains. Meltwater streams that entered a lake rapidly lost speed and also quickly dropped the sands and gravels they carried, forming deltas at the edge of the lake. Very fine sand and silts were commonly redistributed on the lake bottom by wind-generated currents, and the clays, which stayed in suspension longest, slowly settled out and accumulated with them.

Along the ice front, meltwater ran off in innumerable shifting and short-lived streams that laid down a broad, flat blanket of outwash that formed an **outwash plain**. Outwash was also carried away from the glacier in valleys cut by floods of meltwater. The Mississiippi, Illinois, and Ohio Rivers occupy valleys that were major channels for meltwaters and were greatly widened and deepened during times of the greatest meltwater floods. When the floods waned, these valleys were partly filled with outwash far beyond the ice margins. Such outwash deposits, largely sand and gravel, are known as **valley trains**. Valley train deposits may be both extensive and thick. For instance, the long valley train of the Mississippi Valley is locally as much as 200 feet thick.

Loess, Eolian Sand and Soils

One of the most widespread sediments resulting from glaciation was carried not by ice or water but by wind. **Loess** is the name given to windblown deposits dominated by silt. Most of the silt was derived from wind erosion of the valley trains. Wind action also sorted out **eolian sand** which commonly formed **sand dunes** on the valley trains or on the adjacent uplands. In places, sand dunes have migrated up to 10 miles away from the principle source of sand. Flat areas between dunes are generally underlain by eolian **sheet sand** that is commonly reworked by water action. On uplands along the major valley trains, loess and eolian sand are commonly interbedded. With increasing distance from the valleys, the eolian sand pinches out, often within one mile.

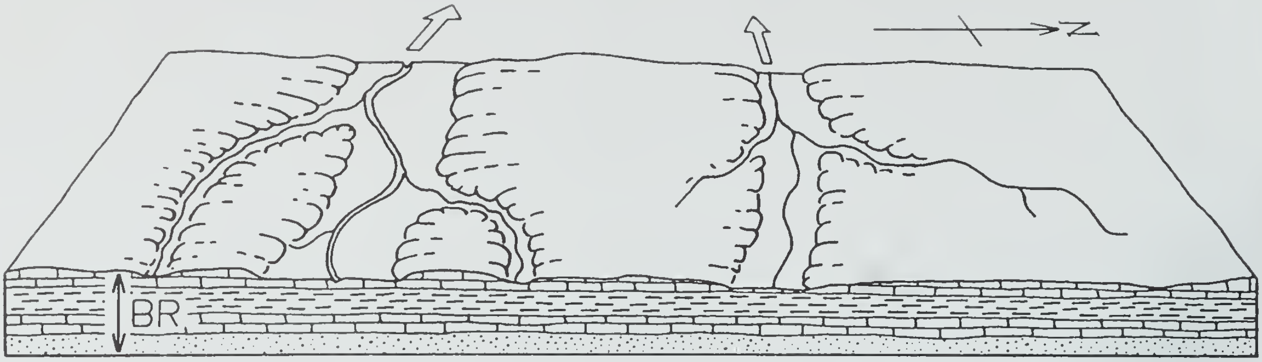
Eolian deposition occurred when certain climatic conditions were met, probably in a seasonal pattern. Deposition could have occurred in the fall, winter or spring season when low precipitation rates and low temperatures caused meltwater floods to abate, exposing the surfaces of the valley trains and permitting them to dry out. During Pleistocene time, as now, west winds prevailed, and the loess deposits are thickest on the east sides of the source valleys. The loess thins rapidly away from the valleys but extends over almost all the state.

Each Pleistocene glaciation was followed by an interglacial stage that began when the climate warmed enough to melt the glaciers and their snowfields. During these warmer intervals, when the climate was similar to that of today, drift and loess surfaces were exposed to weather and the activities of living things. Consequently, over most of the glaciated terrain, soils developed on the Pleistocene deposits and altered their composition, color, and texture. Such soils were generally destroyed by later glacial advances, but some were buried. Those that survive serve as "key beds," or stratigraphic markers, and are evidence of the passage of a long interval of time.

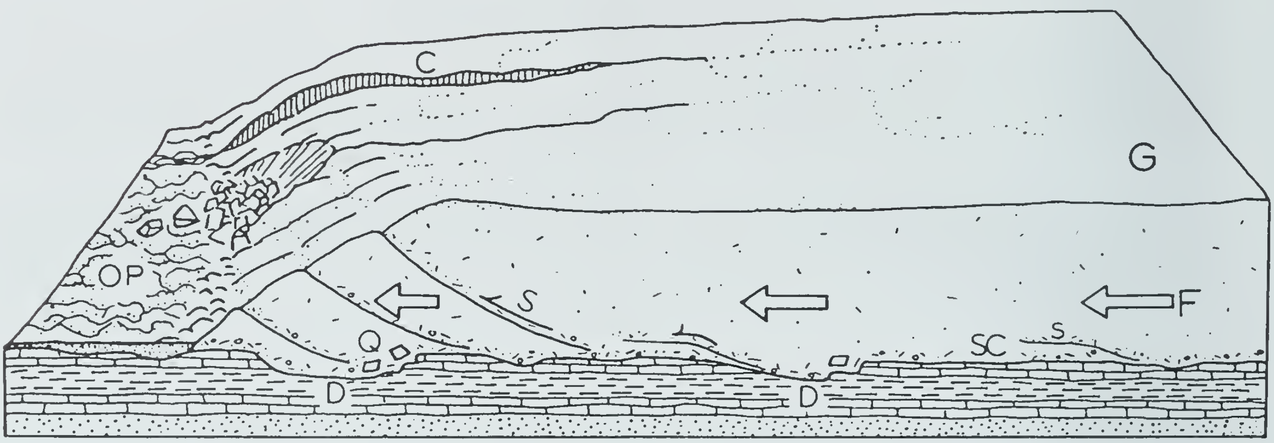
Glaciation in a Small Illinois Region

The following diagrams show how a continental ice sheet might have looked at various stages as it moved across a small region in Illinois. They illustrate how it could change the old terrain and create a landscape like the one we live on. To visualize how these glaciers looked, geologists study the landforms and materials left in the glaciated regions and also the present-day mountain glaciers and polar ice caps.

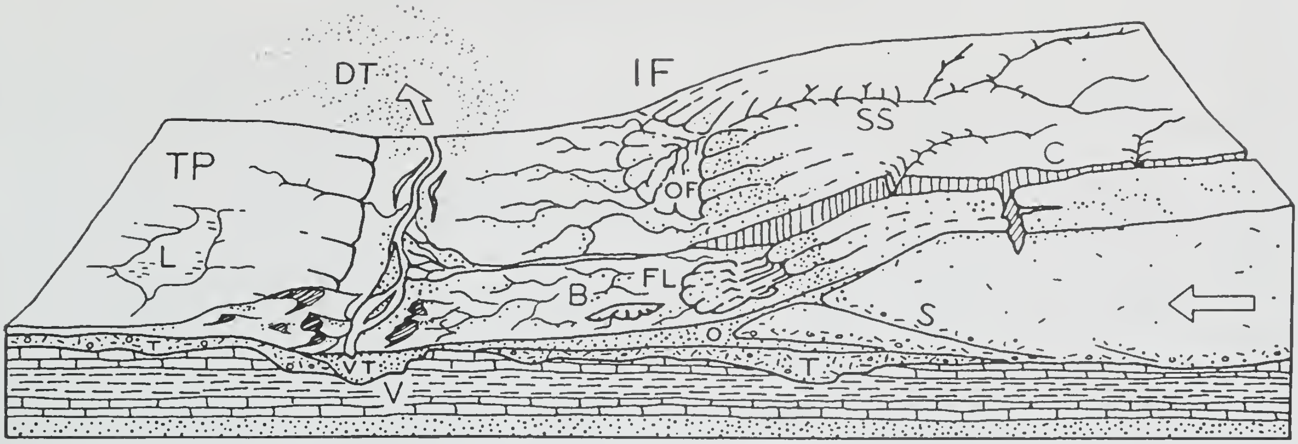
The block of land in the diagrams is several miles wide and about 10 miles long. The vertical scale is exaggerated—layers of material are drawn thicker and landforms higher than they ought to be so that they can be easily seen.



1. **The Region Before Glaciation** — Like most of Illinois, the region illustrated is underlain by almost flat-lying beds of sedimentary rocks—layers of sandstone ( ), limestone ( ), and shale ( ). Millions of years of erosion have planed down the bedrock (BR), creating a terrain of low uplands and shallow valleys. A residual soil weathered from local rock debris covers the area but is too thin to be shown in the drawing. The streams illustrated here flow westward and the one on the right flows into the other at a point beyond the diagram.



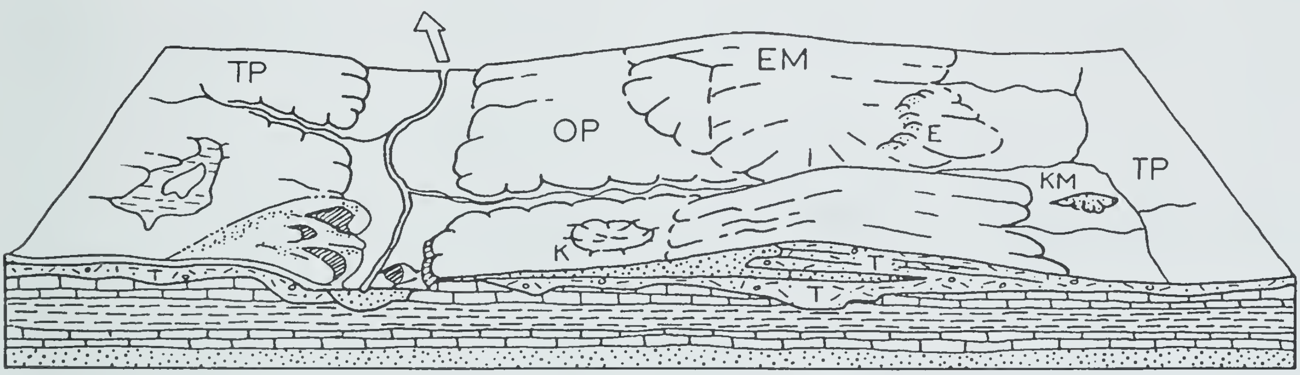
2. **The Glacier Advances Southward** — As the Glacier (G) spreads out from its ice snowfield accumulation center, it scours (SC) the soil and rock surface and quarries (Q)—pushes and plucks up—chunks of bedrock. The materials are mixed into the ice and make up the glacier's "load." Where roughnesses in the terrain slow or stop flow (F), the ice "current" slides up over the blocked ice on innumerable shear planes (S). Shearing mixes the load very thoroughly. As the glacier spreads, long cracks called "crevasses" (C) open parallel to the direction of ice flow. The glacier melts as it flows forward, and its meltwater erodes the terrain in front of the ice, deepening (D) some old valleys before ice covers them. Meltwater washes away some of the load freed by melting and deposits it on the outwash plain (OP). The advancing glacier overrides its outwash and in places scours much of it up again. The glacier may be 5000 or so feet thick, and tapers to the margin, which was probably in the range of several hundred feet above the old terrain. The ice front advances perhaps as much as a third of a mile per year.



3. **The Glacier Deposits an End Moraine** — After the glacier advances across the area, the climate warms and the ice begins to melt as fast as it advances. The ice front (IF) is now stationary, or fluctuating in a narrow area, and the glacier is depositing an end moraine.

As the top of the glacier melts, some of the sediment that is mixed in the ice accumulates on top of the glacier. Some is carried by meltwater onto the sloping ice front (IF) and out onto the plain beyond. Some of the debris slips down the ice front in a mudflow (FL). Meltwater runs through the ice in a crevasse (C). A supraglacial stream (SS) drains the top of the ice, forming an outwash fan (OF). Moving ice has overridden an immobile part of the front on a shear plane (S). All but the top of a block of ice (B) is buried by outwash (O).

Sediment from the melted ice of the previous advance (figure 2) remains as a till layer (T), part of which forms the till plain (TP). A shallow, marshy lake (L) fills a low place in the plain. Although largely filled with drift, the valley (V) remains a low spot in the terrain. As soon as the ice cover melts, meltwater drains down the valley, cutting it deeper. Later, outwash partly refills the valley: the outwash deposit is called a valley train (VT). Wind blows dust (DT) off the dry floodplain. The dust will form a loess deposit when it settles. Sand dunes (D) form on the south and east sides of streams.



4. **The Region after Glaciation** — As the climate warms further, the whole ice sheet melts, and glaciation ends. The end moraine (EM) is a low, broad ridge between the outwash plain (OP) and till plains (TP). Run-off from rains cuts stream valleys into its slopes. A stream goes through the end moraine along the channel cut by the meltwater that ran out of the crevasse in the glacier.

Slopewash and vegetation are filling the shallow lake. The collapse of outwash into the cavity left by the ice block's melting has made a kettle (K). The outwash that filled a tunnel draining under the glacier is preserved in an esker (E). The hill of outwash left where meltwater dumped sand and gravel into a crevasse or other depression in the glacier or at its edge is a kame (KM). A few feet of loess covers the entire area but cannot be shown at this scale.

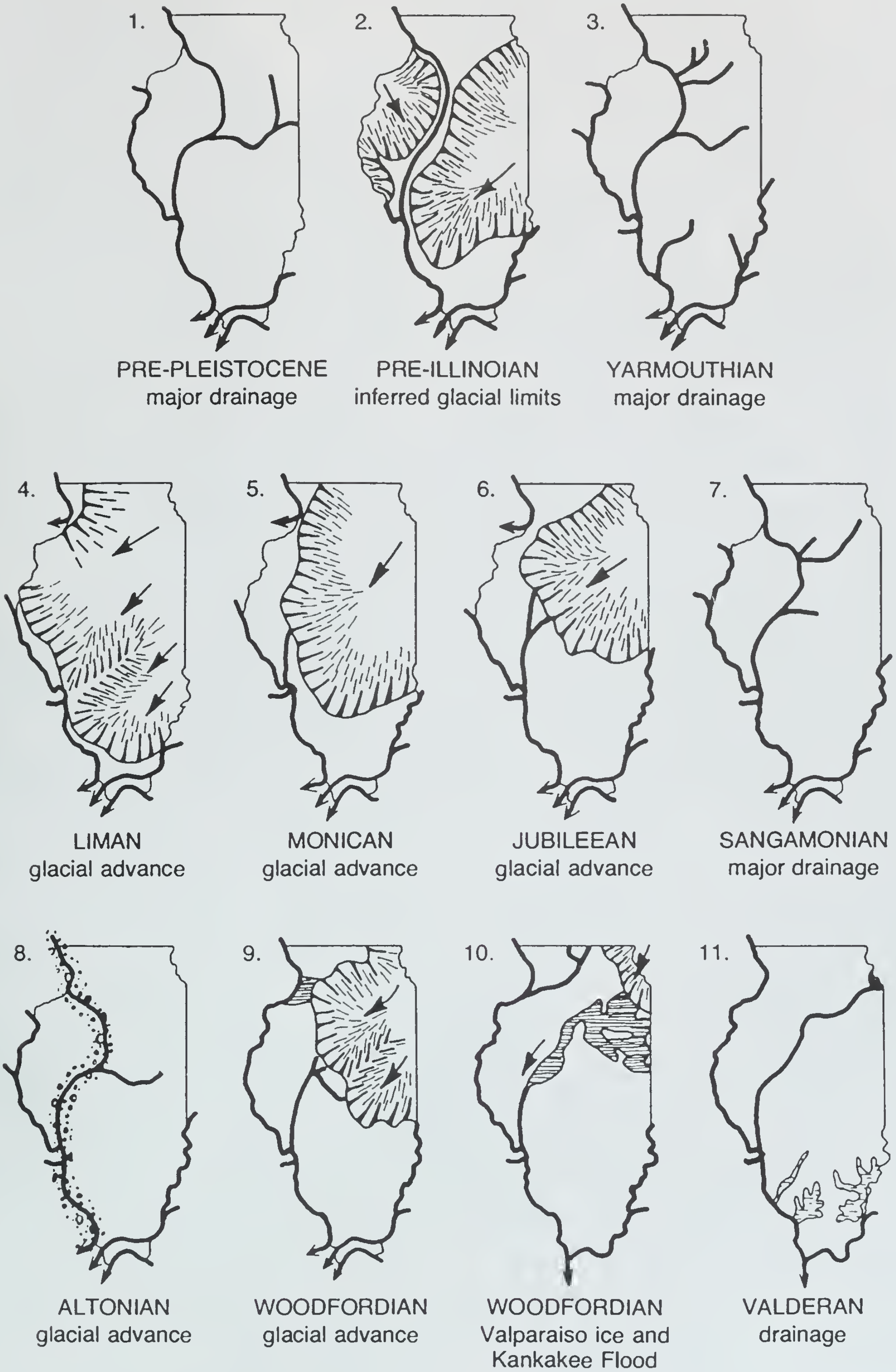
TIME TABLE OF PLEISTOCENE GLACIATION

			STAGE	SUBSTAGE	NATURE OF DEPOSITS	SPECIAL FEATURES
QUATERNARY			HOLOCENE (interglacial)	Years Before Present	Soil, youthful profile of weathering, lake and river deposits, dunes, peat	
				10,000		
	Pleistocene		WISCONSINAN (glacial)	Valderan	Outwash, lake deposits	Outwash along Mississippi Valley
				11,000		
				Twocreekan	Peat and alluvium	Ice withdrawal, erosion
				12,500		
		late		Woodfordian	Drift, loess, dunes, lake deposits	Glaciation; building of many moraines as far south as Shelbyville; extensive valley trains, outwash plains, and lakes
				25,000		
		mid		Farmdalian	Soil, silt, and peat	Ice withdrawal, weathering, and erosion
				28,000		
		early		Altonian	Drift, loess	Glaciation in Great Lakes area, valley trains along major rivers
				75,000		
			SANGAMONIAN (interglacial)		Soil, mature profile of weathering	Important stratigraphic marker
				125,000		
			ILLINOIAN (glacial)	Jubileean	Drift, loess, outwash	Glaciers from northeast at maximum reached Mississippi River and nearly to southern tip of Illinois
				Monican	Drift, loess, outwash	
				Liman	Drift, loess, outwash	
				300,000?		
			YARMOUTHIAN (interglacial)		Soil, mature profile of weathering	Important stratigraphic marker
				500,000?		
		Pre-Illinoian	KANSAN* (glacial)		Drift, loess	Glaciers from northeast and northwest covered much of state
				700,000?		
			AFTONIAN* (interglacial)		Soil, mature profile of weathering	(hypothetical)
				900,000?		
			NEBRASKAN* (glacial)		Drift (little known)	Glaciers from northwest invaded western Illinois
				1,600,000 or more		

*Old oversimplified concepts, now known to represent a series of glacial cycles.

(Illinois State Geological Survey, 1973

SEQUENCE OF GLACIATIONS AND INTERGLACIAL
DRAINAGE IN ILLINOIS



(Modified from Willlman and Frye, "Pleistocene Stratigraphy of Illinois," ISGS Bull. 94, fig. 5, 1970.)

ILLINOIS STATE GEOLOGICAL SURVEY

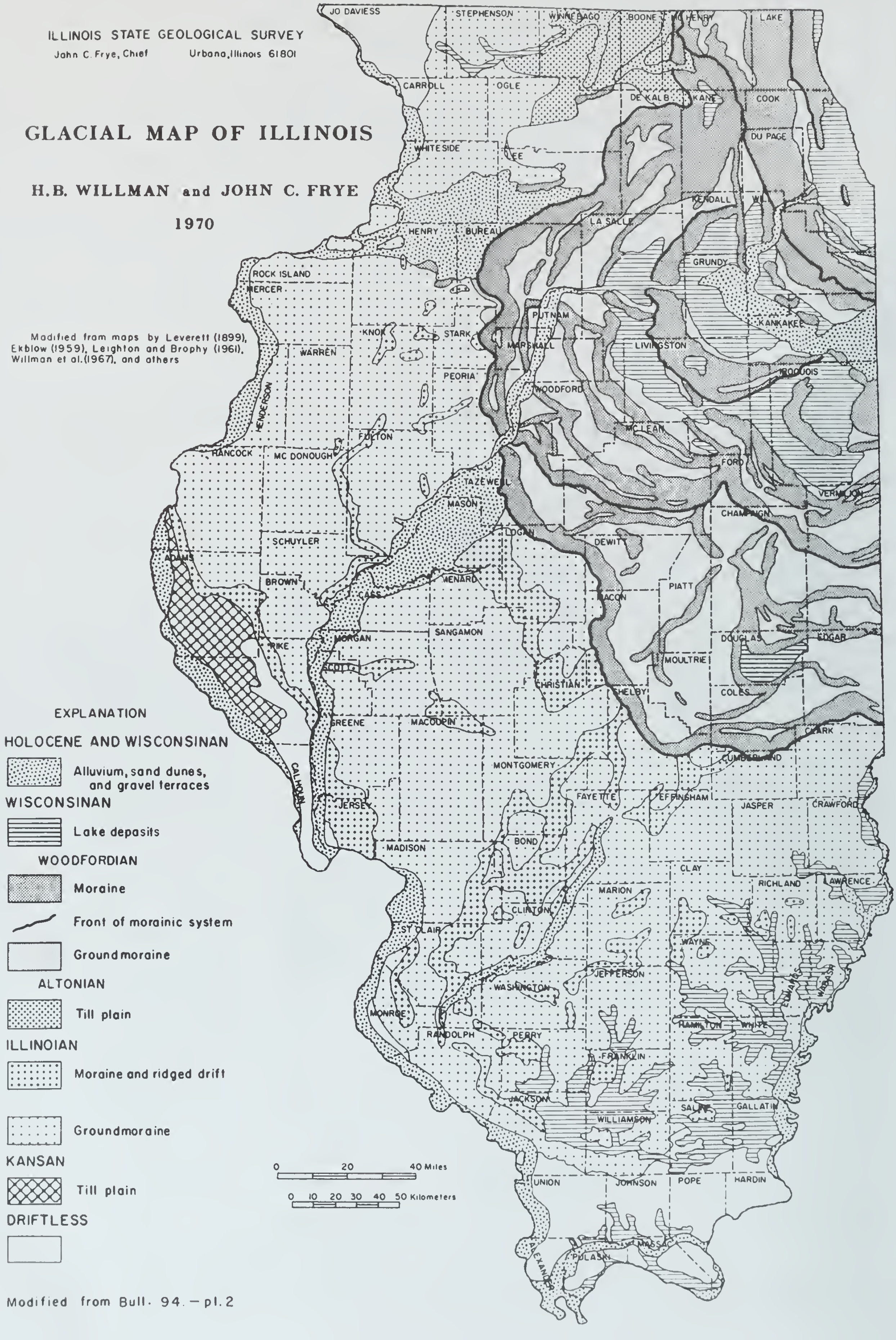
John C. Frye, Chief   Urbana, Illinois 61801

GLACIAL MAP OF ILLINOIS

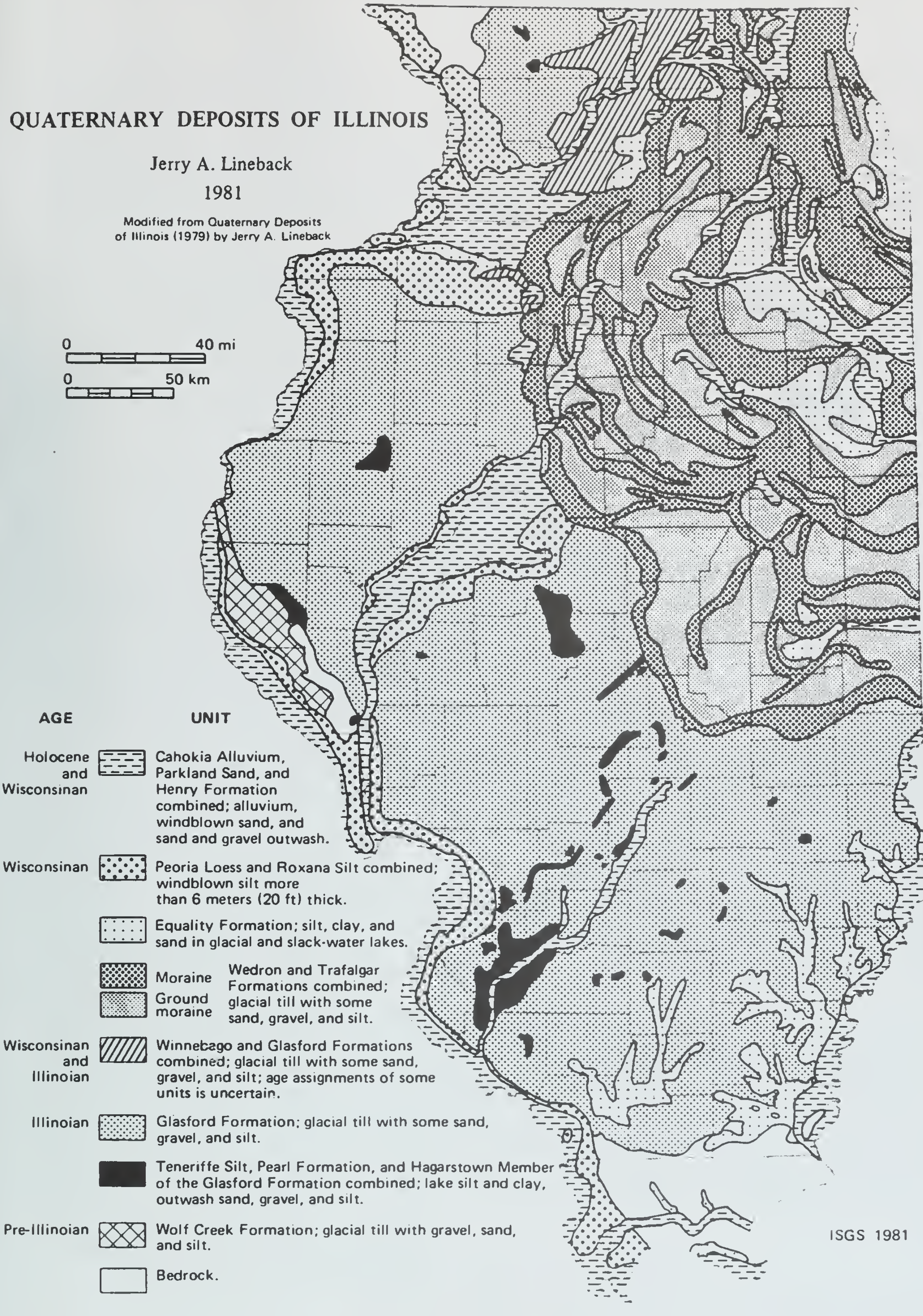
H.B. WILLMAN and JOHN C. FRYE

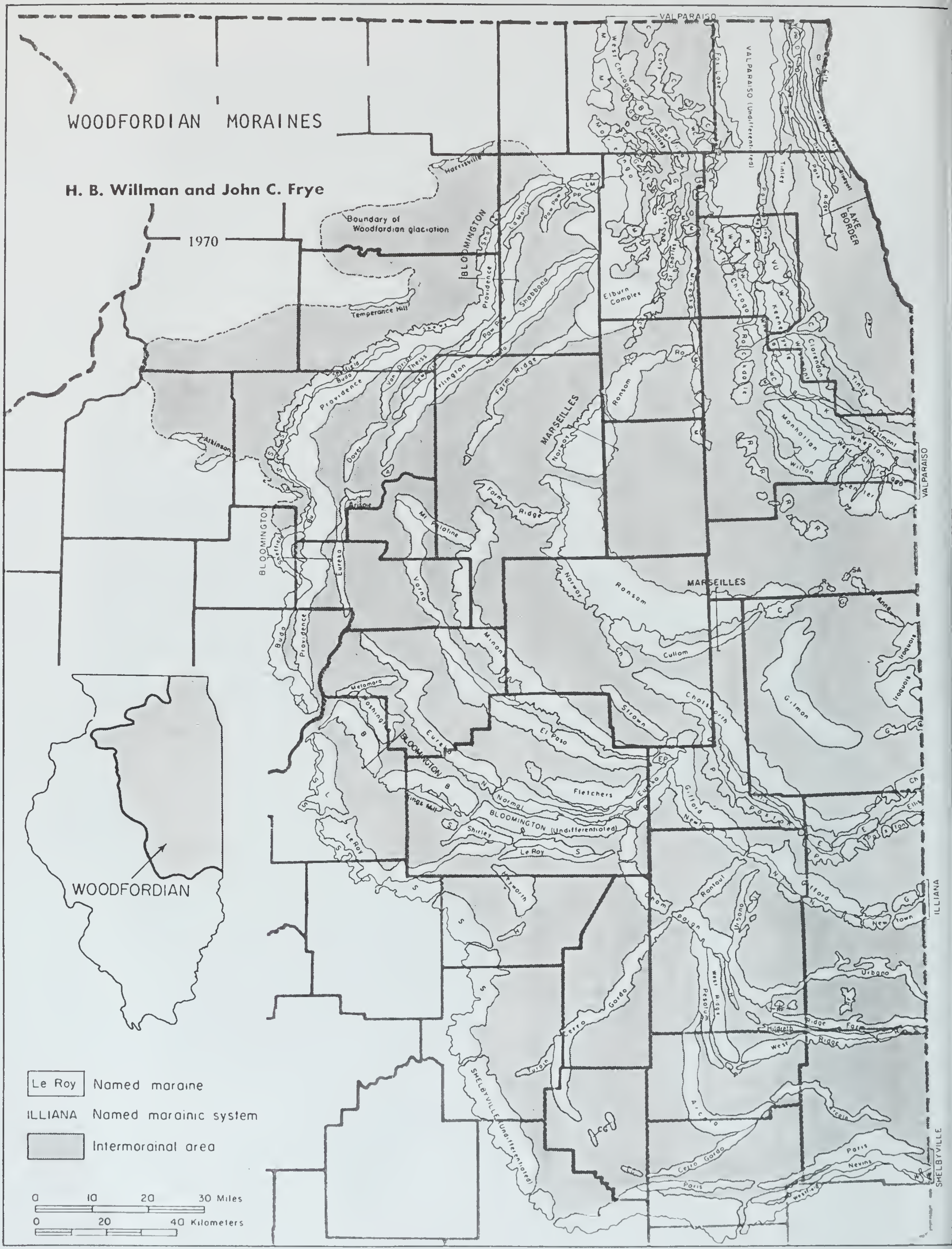
1970

Modified from maps by Leverett (1899), Ekblow (1959), Leighton and Brophy (1961), Willman et al. (1967), and others



Modified from Bull. 94.—pl.2


QUATERNARY DEPOSITS OF ILLINOIS
Jerry A. Lineback
1981
Modified from Quaternary Deposits of Illinois (1979) by Jerry A. Lineback
0 40 mi
0 50 km
AGE
UNIT
Holocene and Wisconsinan
Cahokia Alluvium, Parkland Sand, and Henry Formation combined; alluvium, windblown sand, and sand and gravel outwash.
Wisconsinan
Peoria Loess and Roxana Silt combined; windblown silt more than 6 meters (20 ft) thick.
Equality Formation; silt, clay, and sand in glacial and slack-water lakes.
Moraine
Ground moraine
Wedron and Trafalgar Formations combined; glacial till with some sand, gravel, and silt.
Wisconsinan and Illinoian
Winnebago and Glasford Formations combined; glacial till with some sand, gravel, and silt; age assignments of some units is uncertain.
Illinoian
Glasford Formation; glacial till with some sand, gravel, and silt.
Teneriffe Silt, Pearl Formation, and Hagarstown Member of the Glasford Formation combined; lake silt and clay, outwash sand, gravel, and silt.
Pre-Illinoian
Wolf Creek Formation; glacial till with gravel, sand, and silt.
Bedrock.
ISGS 1981


WOODFORDIAN MORAINES
H. B. Willman and John C. Frye
1970
Boundary of Woodfordian glaciation
VALPARAISO
LAKE BORDER
BLOOMINGTON
MARSEILLES
ILLIANA
SHELBYVILLE
BLOOMINGTON (Undifferentiated)
SHELBYVILLE (Undifferentiated)
VALPARAISO (Undifferentiated)
WOODFORDIAN
Le Roy Named moraine
ILLIANA Named morainic system
Intermorainal area
0 10 20 30 Miles
0 20 40 Kilometers

DEPOSITIONAL HISTORY OF THE PENNSYLVANIAN ROCKS IN ILLINOIS

At the close of the Mississippian Period, about 310 million years ago, the sea withdrew from the Midcontinent region. A long interval of erosion that took place early in Pennsylvanian time removed hundreds of feet of the pre-Pennsylvanian strata, completely stripping them away and cutting into older rocks over large areas of the Midwest. Ancient river systems cut deep channels into the bedrock surface. Later, but still during early Pennsylvanian (Morrowan) time, the sea level started to rise; the corresponding rise in the base level of deposition interrupted the erosion and led to filling the valleys in the erosion surface with fluvial, brackish, and marine sands and muds.

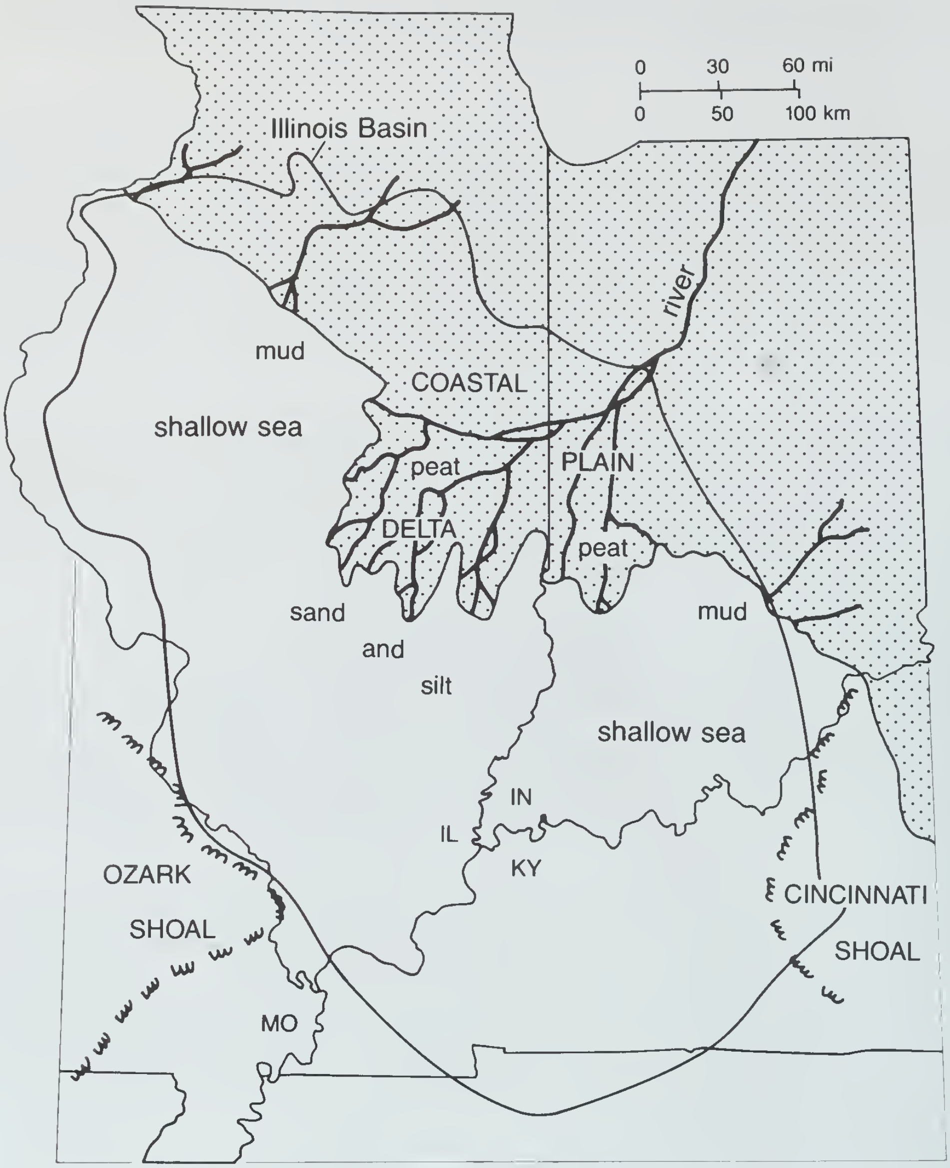
Depositional conditions in the Illinois Basin during the Pennsylvanian Period were somewhat similar to those of the preceding Chesterian (late Mississippian) time. A river system flowed southwestward across a swampy lowland, carrying mud and sand from highlands to the northeast. This river system formed thin but widespread deltas that coalesced into a vast coastal plain or lowland that prograded (built out) into the shallow sea that covered much of present-day Illinois (see paleogeographic map, next page). As the lowland stood only a few feet above sea level, slight changes in relative sea level caused great shifts in the position of the shoreline.

During most of Pennsylvanian time, the Illinois Basin gradually subsided; a maximum of about 3000 feet of Pennsylvanian sediments are preserved in the basin. The locations of the delta systems and the shoreline of the resulting coastal plain shifted, probably because of worldwide sea level changes, coupled with variation in the amounts of sediments provided by the river system and local changes in basin subsidence rates. These frequent shifts in the coastline position caused the depositional conditions at any one locality in the basin to alternate frequently between marine and nonmarine, producing a variety of lithologies in the Pennsylvanian rocks (see lithology distribution chart).

Conditions at various places on the shallow sea floor favored the deposition of sand, lime mud, or mud. Sand was deposited near the mouths of distributary channels, where it was reworked by waves and spread out as thin sheets near the shore. Mud was deposited in quiet-water areas — in delta bays between distributaries, in lagoons behind barrier bars, and in deeper water beyond the nearshore zone of sand deposition. Limestone was formed from the accumulation of limy parts of plants and animals laid down in areas where only minor amounts of sand and mud were being deposited. The areas of sand, mud, and limy mud deposition continually changed as the position of the shoreline changed and as the delta distributaries extended seaward or shifted their positions laterally along the shore.

Nonmarine sand, mud, and lime mud were deposited on the coastal plain bordering the sea. The nonmarine sand was deposited in delta distributary channels, in river channels, and on the broad floodplains of the rivers. Some sand bodies 100 or more feet thick were deposited in channels that cut through the underlying rock units. Mud was deposited mainly on floodplains. Some mud and freshwater lime mud were deposited locally in fresh-water lakes and swamps.

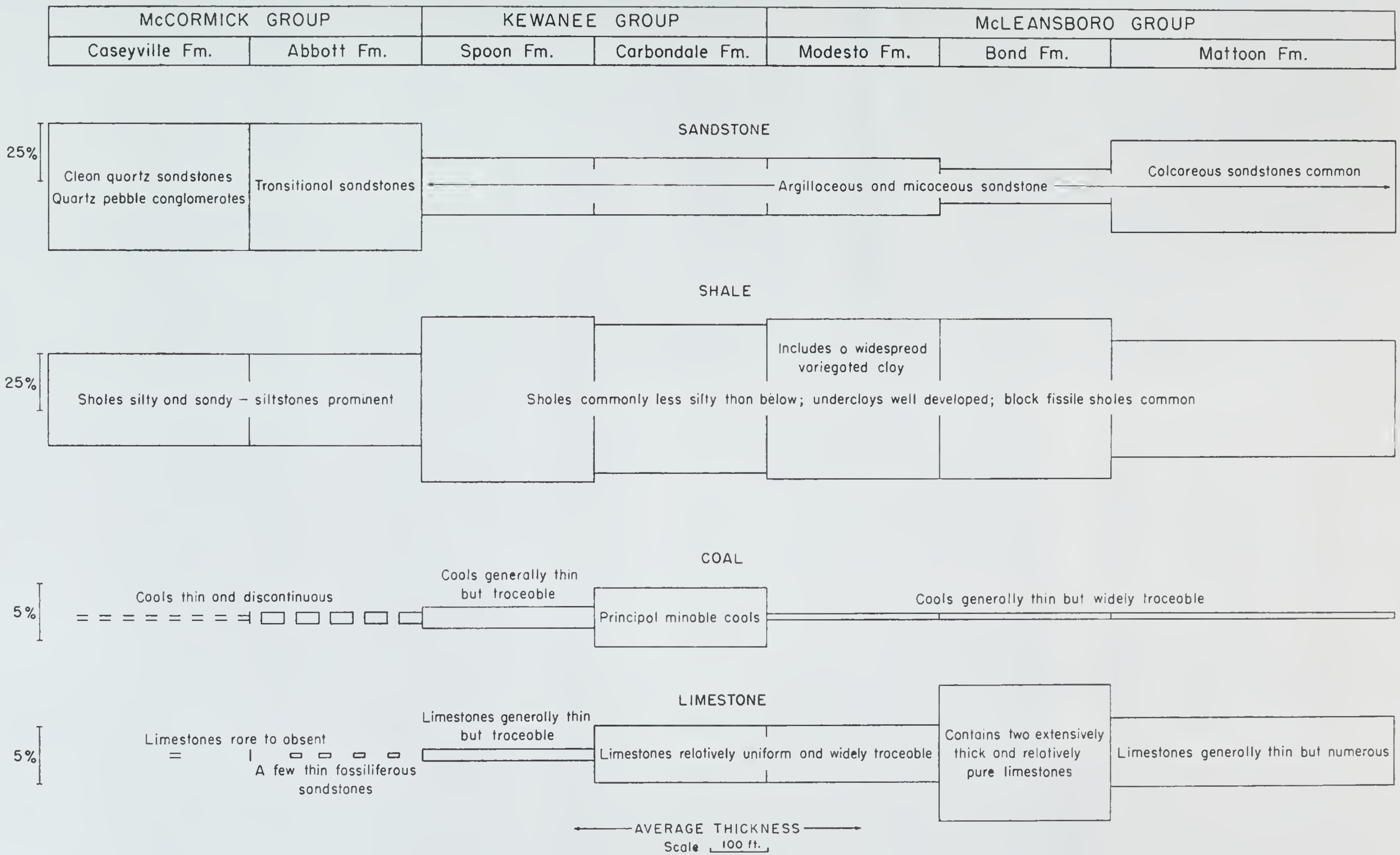
Beneath the quiet water of extensive swamps that prevailed for long intervals on the emergent coastal lowland, peat was formed by accumulation of plant material. Lush forest vegetation covered the region; it thrived in the warm, moist Pennsylvanian-age climate. Although the origin of the underclays beneath the coal is not precisely known, most evidence indicates that they were deposited in the swamps as slackwater mud before the accumulation of much plant debris. The clay underwent modification to become the soil upon which the lush vegetation grew in the swamps. Underclay frequently contains plant roots and rootlets that appear to be in their original places. The vast swamps were the culmination of nonmarine deposition. Resubmergence of the borderlands by the sea interrupted nonmarine deposition, and marine sediments were laid down over the peat.



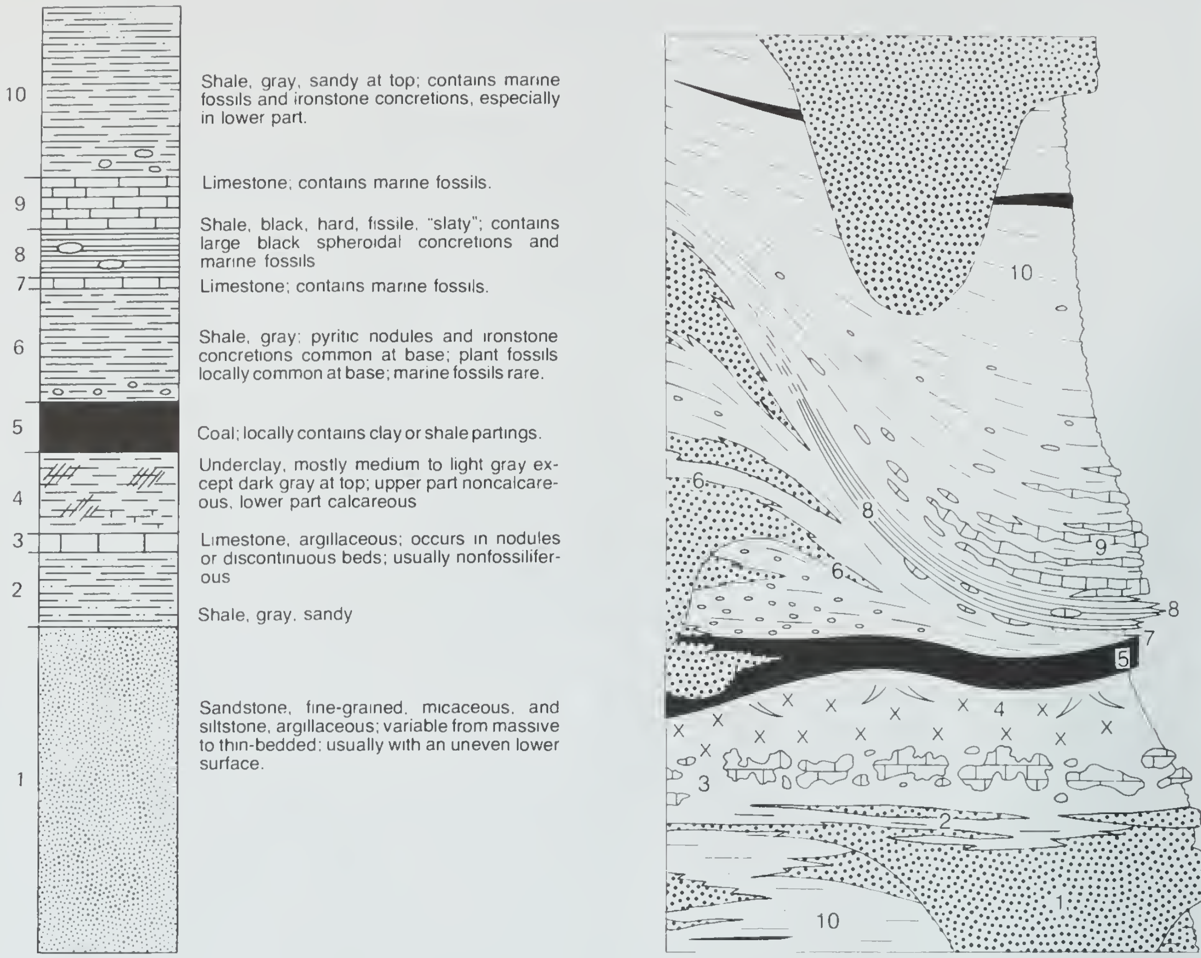
Paleogeography of Illinois-Indiana region during Pennsylvanian time. The diagram shows a Pennsylvanian river delta and the position of the shoreline and the sea at an instant of time during the Pennsylvanian Period.

Pennsylvanian Cyclothems

The Pennsylvanian strata exhibit extraordinary variations in thickness and composition both laterally and vertically because of the extremely varied environmental conditions under which they formed. Individual sedimentary units are often only a few inches thick and rarely exceed 30 feet thick. Sandstones and shales commonly grade laterally into each other, and shales sometimes interfinger and grade into limestones and coals. The underclays, coals, black shales, and some limestones, however, display remarkable lateral continuity for such thin units. Coal seams have been traced in mines, outcrops, and subsurface drill records over areas comprising several states.



General distribution of the four principal lithologies in Pennsylvanian strata of Illinois.



The idealized cyclothem at left (after Willman and Payne, 1942) infers continuous, widespread distribution of individual cyclothem units, at right the model of a typical cyclothem (after Baird and Shabica, 1980) shows the discontinuous nature of many units in a cyclothem.

The rapid and frequent changes in depositional environments during Pennsylvanian time produced regular or cyclical alternations of sandstone, shale, limestone, and coal in response to the shifting shoreline. Each series of alternations, called a cyclothem, consists of several marine and nonmarine rock units that record a complete cycle of marine invasion and retreat. Geologists have determined, after extensive studies of the Pennsylvanian strata in the Midwest, that an "ideally" complete cyclothem consists of ten sedimentary units (see illustration above contrasting the model of an "ideal" cyclothem with a model showing the dynamic relationships between the various members of a typical cyclothem).

Approximately 50 cyclothems have been described in the Illinois Basin but only a few contain all ten units at any given location. Usually one or more are missing because conditions of deposition were more varied than indicated by the "ideal" cyclothem. However, the order of units in each cyclothem is almost always the same: a typical cyclothem includes a basal sandstone overlain by an underclay, coal, black sheety shale, marine limestone, and gray marine shale. In general, the sandstone-underclay-coal-gray shale portion (the lower six units) of each cyclothem is nonmarine: it was deposited as part of the coastal lowlands from which the sea had withdrawn. However, some of the sandstones are entirely or partly marine. The units above the coal and gray shale are marine sediments deposited when the sea advanced over the coastal plain.

Origin of Coal

It is generally accepted that the Pennsylvanian coals originated by the accumulation of vegetable matter, usually in place, beneath the waters of extensive, shallow, fresh-to-brackish swamps. They represent the last-formed deposits of the nonmarine portions of the cyclothems. The swamps occupied vast areas of the coastal lowland, which bordered the shallow Pennsylvanian sea. A luxuriant growth of forest plants, many quite different from the plants of today, flourished in the warm, humid Pennsylvanian climate. (Illinois at that time was near the equator.) The deciduous trees and flowering plants that are common today had not yet evolved. Instead, the jungle-like forests were dominated by giant ancestors of present-day club mosses, horsetails, ferns, conifers, and cycads. The undergrowth also was well developed, consisting of many ferns, fernlike plants, and small club mosses. Most of the plant fossils found in the coals and associated sedimentary rocks show no annual growth rings, suggesting rapid growth rates and lack of seasonal variations in the climate (tropical). Many of the Pennsylvanian plants, such as the seed ferns, eventually became extinct.

Plant debris from the rapidly growing swamp forests — leaves, twigs, branches, and logs — accumulated as thick mats of peat on the floors of the swamps. Normally, vegetable matter rapidly decays by oxidation, forming water, nitrogen, and carbon dioxide. However, the cover of swamp water, which was probably stagnant and low in oxygen, prevented oxidation, and any decay of the peat deposits was due primarily to bacterial action.

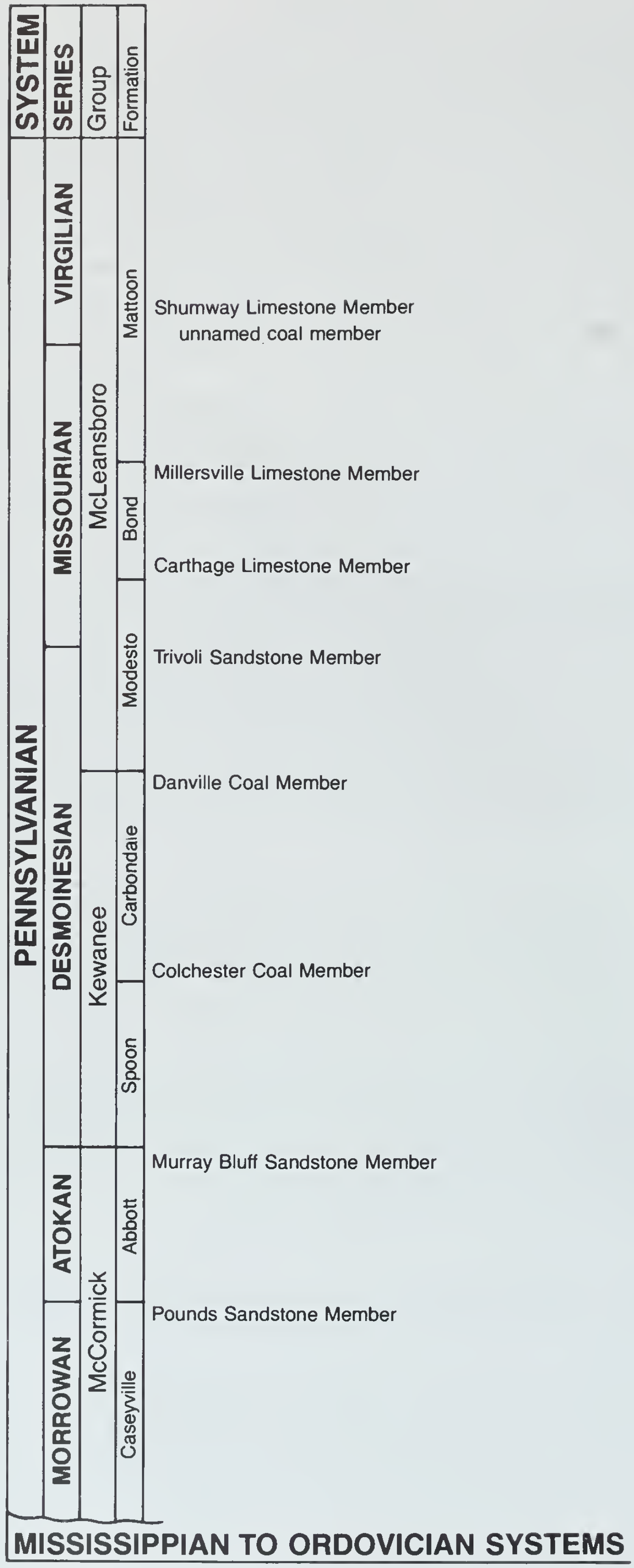
The periodic invasions of the Pennsylvanian sea across the coastal swamps killed the Pennsylvanian forests, and the peat deposits were often buried by marine sediments. After the marine transgressions, peat usually became saturated with sea water containing sulfates and other dissolved minerals. Even the marine sediments being deposited on the top of the drowned peat contained various minerals in solution, including sulfur, which further infiltrated the peat. As a result, the peat developed into a coal that is high in sulfur. However, in a number of areas, nonmarine muds, silts, and sands from the river system on the coastal plain covered the peat where flooding broke through levees or the river changed its coarse. Where these sediments (unit 6 of the cyclothem) are more than 20 feet thick, we find that the coal is low in sulfur, whereas coal found directly beneath marine rocks is high in sulfur. Although the seas did cover the areas where these nonmarine, fluvial sediments covered the peat, the peat was protected from sulfur infiltration by the shielding effect of these thick fluvial sediments.

Following burial, the peat deposits were gradually transformed into coal by slow physical and chemical changes in which pressure (compaction by the enormous weight of overlying sedimentary layers), heat (also due to deep burial), and time were the most important factors. Water and volatile substances (nitrogen, hydrogen, and oxygen) were slowly driven off during the coal-forming ("coalification") process, and the peat deposits were changed into coal.

Coals have been classified by ranks that are based on the degree of coalification. The commonly recognized coals, in order of increasing rank, are (1) brown coal or lignite, (2) sub-bituminous, (3) bituminous, (4) semibituminous, (5) semianthracite, and (6) anthracite. Each increase in rank is characterized by larger amounts of fixed carbon and smaller amounts of oxygen and other volatiles. Hardness of coal also increases with increasing rank. All Illinois coals are classified as bituminous.

Underclays occur beneath most of the coals in Illinois. Because underclays are generally unstratified (unlayered), are leached to a bleached appearance, and generally contain plant roots, many geologists consider that they represent the ancient soils on which the coal-forming plants grew.

The exact origin of the carbonaceous black shale that occurs above many coals is uncertain. Current thinking suggests that the black shale actually represents the deepest part of the marine transgression. Maximum transgression of the sea, coupled with upwelling of ocean water and accumulation of mud and animal remains on an anaerobic ocean floor, led to the deposition of black organic mud over vast areas stretching from Texas to Illinois. Deposition occurred in quiet-water areas where the very fine-grained iron-rich



Generalized stratigraphic column of the Pennsylvanian in Illinois (1 inch = approximately 250 feet).

mud and finely divided plant debris were washed in from the land. Most of the fossils found in black shale represent planktonic (floating) and nektonic (swimming) forms — not benthonic (bottom-dwelling) forms. The depauperate (dwarf) fossil forms sometimes found in black shale formerly were thought to have been forms that were stunted by toxic conditions in the sulfide-rich, oxygen-deficient water of the lagoons. However, study has shown that the "depauperate" fauna consists mostly of normal-size individuals of species that never grew any larger.

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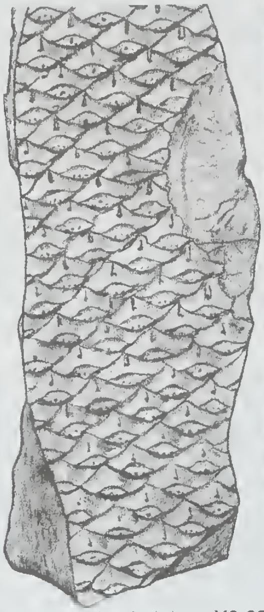
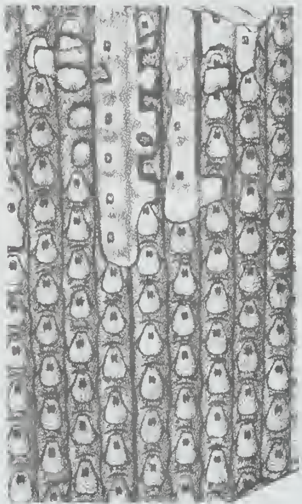
Common Pennsylvanian plants: lycopods, sphenophytes, and ferns

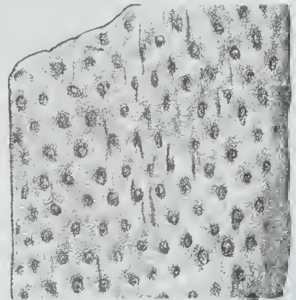
Lepidodendron aculeatum X0.8



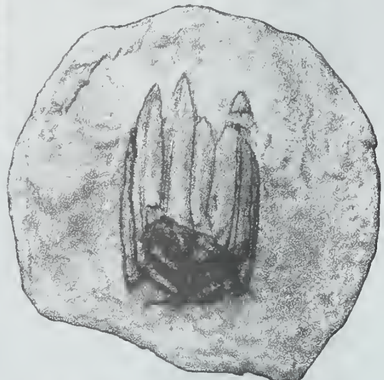
Lepidophloios laricinus X0.63



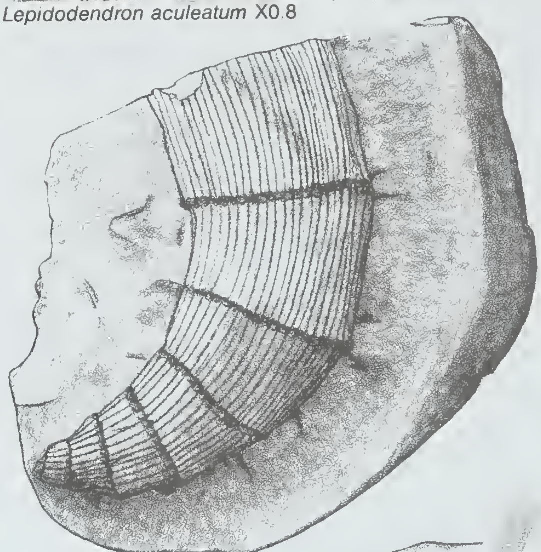
Sigillaria mammilaris X0.5



Stigmaria ficoides X0.32



Lepidostrobus ovatifolius X0.8



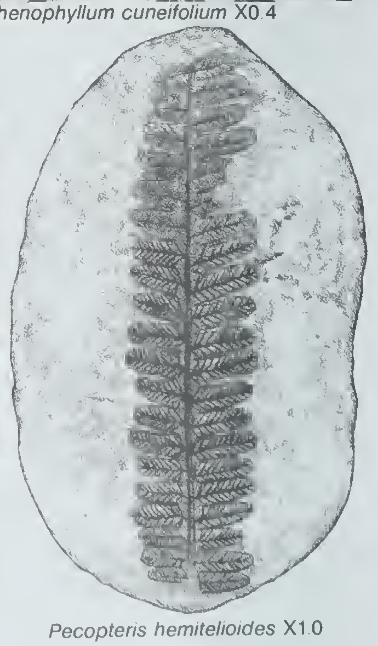
Calamites suckowii X0.5

Annularia stellata X0.63

Sphenophyllum cuneifolium X0.4

Pecopteris sp. X0.32

Pecopteris miltonii X2.0

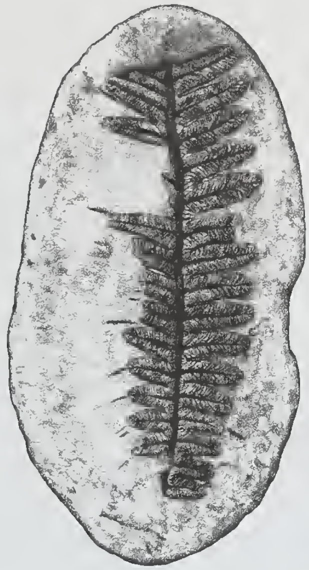


Pecopteris hemitelioides X1.0

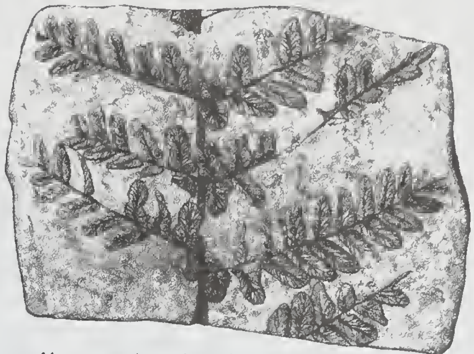
J. R. Jennings, ISGS

Common Pennsylvanian plants: seed ferns and cordaiteans

Alethopteris serlii X0.63



Alethopteris ambigua X0.63

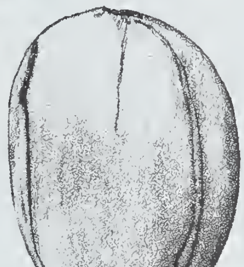


Neuropteris rarinervis X0.5

Mariopteris nervosa X0.8

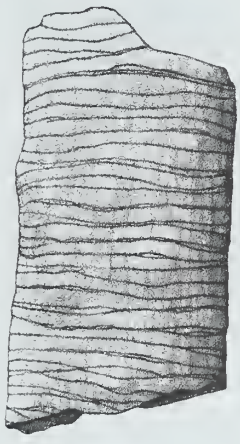
Neuropteris scheuchzeri X0.63

Sphenopteris rotundiloba X0.8



Trigonocarpus parkinsonii X1.25

Cordaicladus sp. X1.0

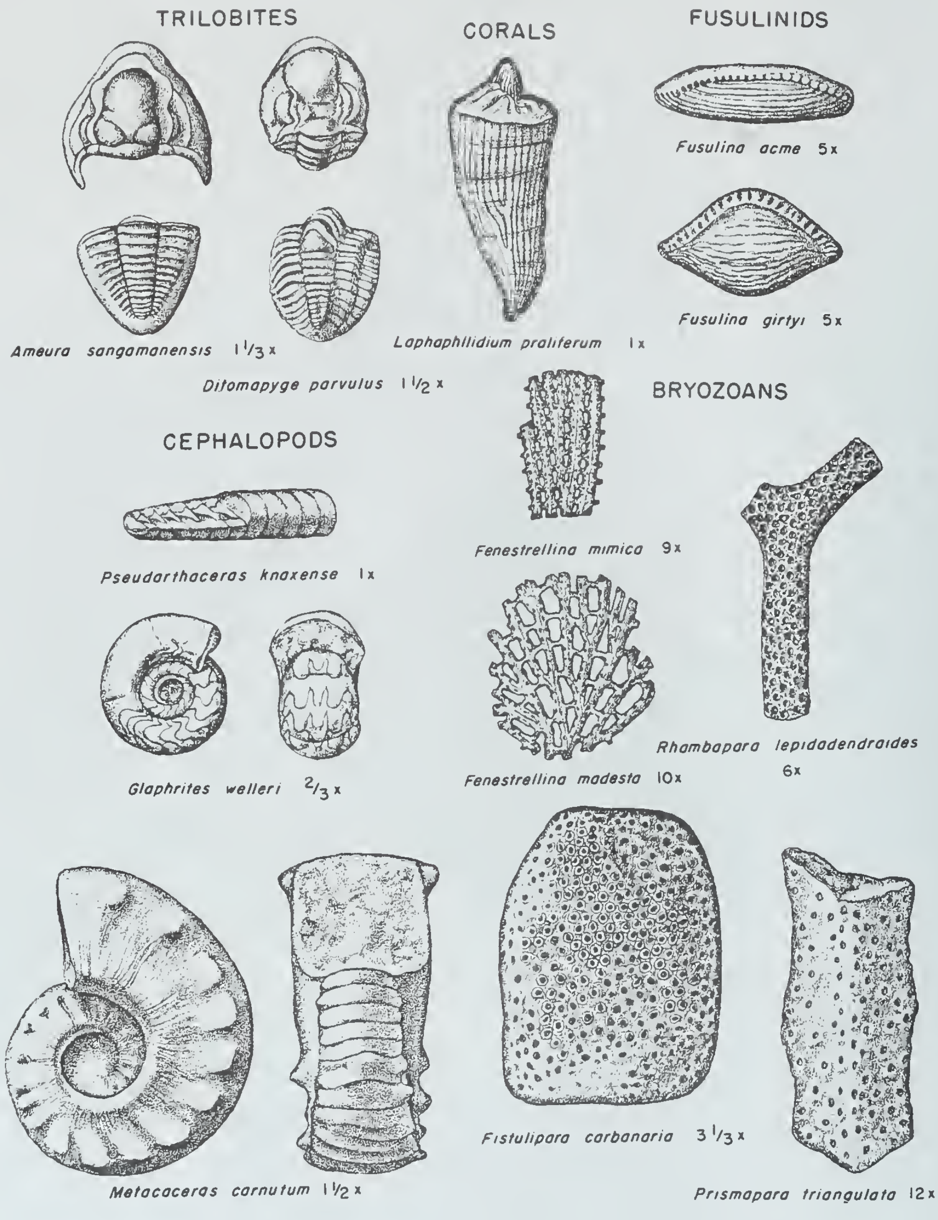


Artisia transversa X0.63

Cordaicarpon major X2.0

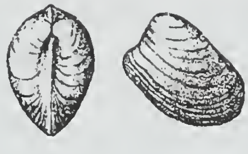
Cordaites principalis X0.63

J. R. Jennings, ISGS



TRILOBITES
CORALS
FUSULINIDS
Fusulina acme 5x
Fusulina girtyi 5x
Ameura sangamonensis 1 1/3 x
Lophophyllidium proliferum 1x
Ditomopyge parvulus 1 1/2 x
BRYOZOANS
CEPHALOPODS
Fenestrellina mimica 9x
Pseudorthoceras knoxense 1x
Rhombopora lepidodendroides 6x
Glaphrites welleri 2/3 x
Fenestrellina modesta 10x
Fistulipora carbonaria 3 1/3 x
Metacoceras cornutum 1 1/2 x
Prismopora triangulata 12x

PELECYPODS



Nucula (Nuculopsis) girtyi 1x

Edmonia ovata 2x

Astartella concentrica 1x

Dunbarella knighti 1 1/2 x

Cardiomorpha missouriensis
"Type A" 1x

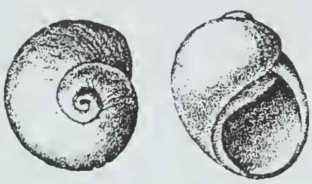
Cardiomorpha missouriensis
"Type B" 1 1/2 x

GASTROPODS

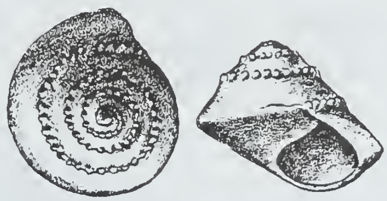
Euphemites carbonarius 1 1/2 x

Trepospira illinoisensis 1 1/2 x

Donaldina robusta 8x



Naticopsis (Jedria) ventricosa 1 1/2 x

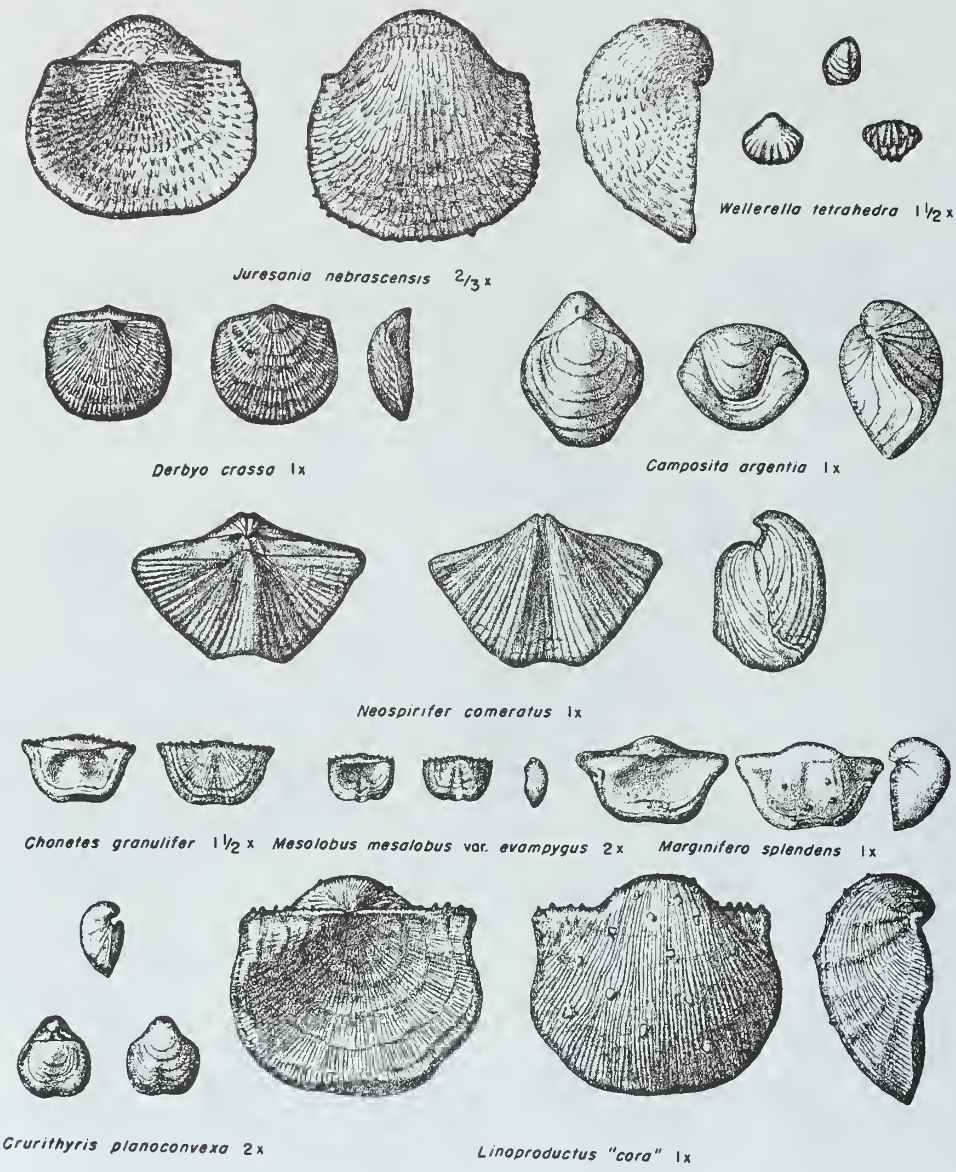


Trepospira sphaerulata 1x

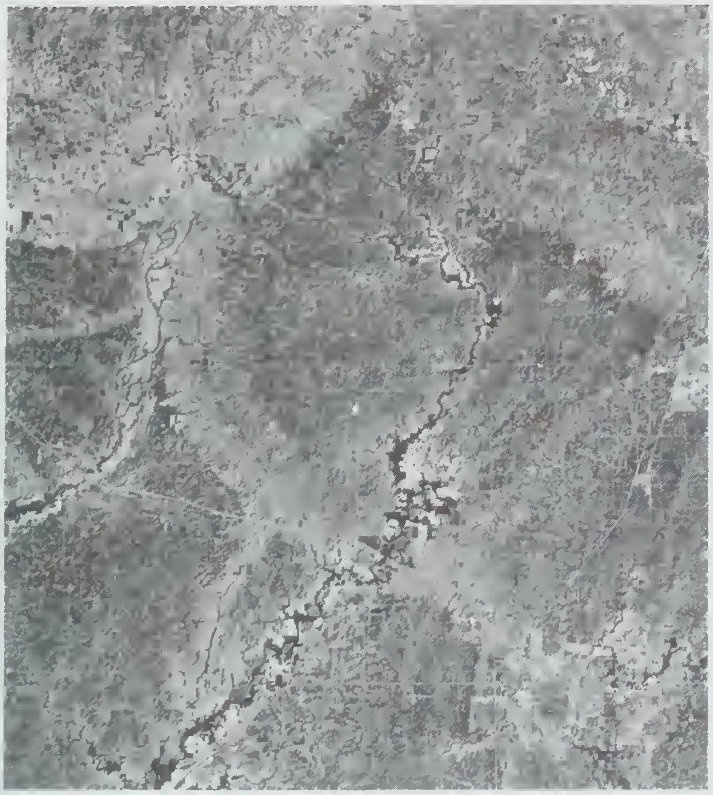
Knightites montfortianus 2x

Glabrocingulum (Glabrocingulum) grayvillense 3x

BRACHIOPODS



END MORAINES—the end of the glacial ride

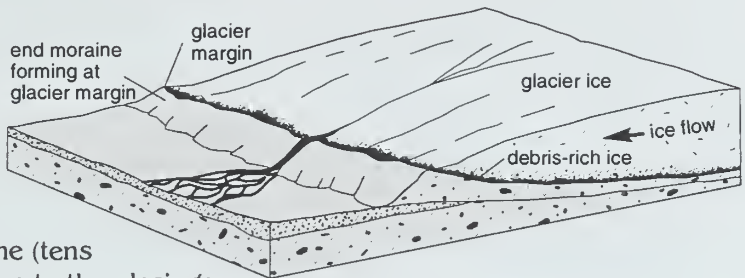


Satellite photo of central Illinois shows broad curved ridges.

We tend to think of Illinois as very flat, but bike riders and joggers know that our landscape has many subtle hills, ridges, and long uphill slopes. From a satellite or the space shuttle high above the earth, large broad ridges can be seen that arc across northeastern Illinois.

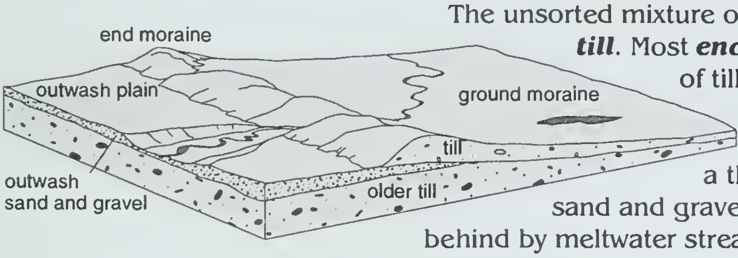
These ridges, left behind when the last Ice Age glaciers melted away, are called end moraines; they formed between about 25,000 and 14,000 years ago during the Wisconsin glacial episode. Although these ridges are easy to see from space, they are so broad and rounded you may sometimes overlook them when you drive across Illinois.

How do end moraines form?

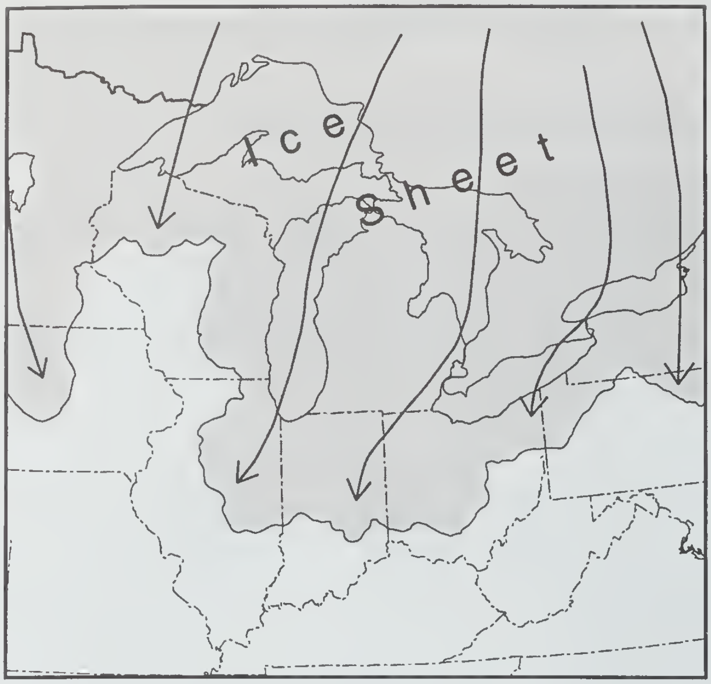


Melting at a glacier margin causes the ice to thin, and ground-up rock debris carried in the base of the ice or dragged along beneath the glacier is deposited. When the ice margin remains in the same place for a relatively long time (tens to hundreds of years), enough debris flows to the glacier's leading edge and piles up to form a large ***end moraine*** on the landscape.

What are end moraines made of?

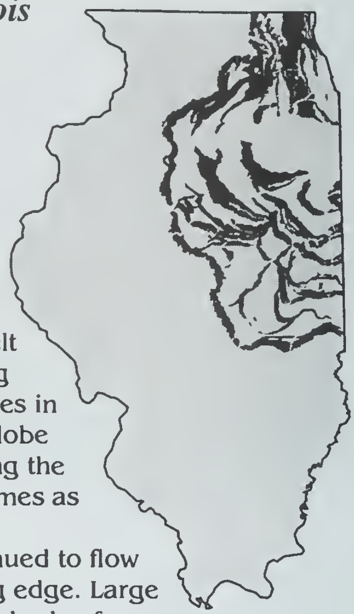


The unsorted mixture of debris deposited by a glacier is called ***till***. Most ***end moraines*** in Illinois are thick ridges of till. A ***ground moraine***, the relatively flat, low-lying landscape across which the melting glacier retreated, consists of a thinner layer of till. Sheetlike deposits of sand and gravel, called ***outwash plains***, were left behind by meltwater streams flowing away from the glacier.



During the Wisconsin glacial episode, a vast sheet of ice formed over most of Canada. Glaciers flowed away from the center of the ice sheet. The glacier that flowed through the Lake Michigan basin and into northeastern Illinois reached its southernmost extent at Shelbyville about 20,000 years ago.

End moraines in northeastern Illinois



The glacier did not just flow into Illinois and then gradually melt away. Its overall retreat was interrupted by many pauses during which moraines formed. Most of the more than 30 end moraines in Illinois (shown as dark arcs on the map) formed as the glacial lobe was "retreating" from its southernmost position. At times during the overall retreat, the ice margin temporarily readvanced, sometimes as much as 50 miles.

Even as the lobe was retreating, however, the glacier continued to flow toward its outer margin, delivering ice and debris to its leading edge. Large moraines mark positions where the ice margin paused for hundreds of years.

Try to spot end moraines the next time you take a drive. *Their rounded crests form the highest parts of the landscape. Radio and TV towers are commonly located atop these moraine ridges*

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contributed by A.K. Hansel

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ILLINOIS DEPARTMENT OF NATURAL RESOURCES

ILLINOIS STATE GEOLOGICAL SURVEY 1905

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EXOTIC ROCKS or Erratics Are Erratic

A piece of Canada sitting in central Illinois (photo by D. Reinertsen).

Here and there in Illinois are boulders lying alone or with companions in the corner of a field or someone's yard, on a courthouse lawn or a schoolyard. Many of them—colorful and glittering granites, banded gneisses, and other intricately veined and streaked igneous and metamorphic rocks—seem out of place in the stoneless, grassy knolls and prairies of our state. Their "erratic" occurrence is the reason for their interesting name.

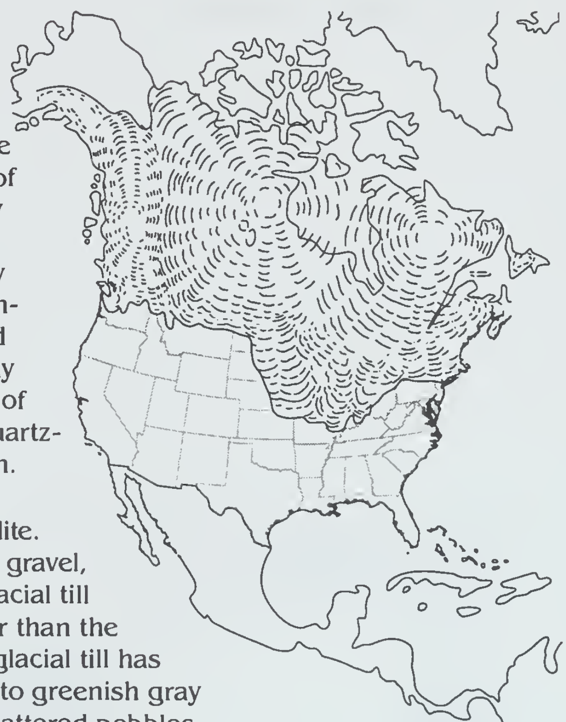
Where did erratics come from?

These exotic rocks came from Canada and the states north of us. The continental glaciers of the Great Ice Age scoured and scraped the land surface as they advanced, pushing up chunks of bedrock and grinding them against each other or along the ground surface as the rock-laden ice sheets pushed southward.

Sometimes you can tell where the erratic originally came from by determining the kind of rock it is. A large boulder of granite, gneiss, or other igneous or metamorphic rock may have come from Canada.

Some erratics containing flecks of copper were probably transported here from the "Copper Range" of the upper peninsula of Michigan. Large pieces of copper have been found in glacial deposits of central and northern Illinois. Light gray to white quartzite boulders with beautiful, rounded pebbles of red jasper came from Ontario, Canada. Purplish pieces of quartzite, some of them banded, probably originated in Wisconsin.

Most interesting are the few large boulders of Canadian tillite. Glacial till is an unsorted and unlayered mixture of clay, sand, gravel, and boulders that vary widely in size and shape. Tillite is glacial till that was deposited by a glacier many millions of years older than the ones that invaded our state during the Great Ice Age. This glacial till has been around so long that it has been hardened into a gray to greenish gray rock containing a mixture of grains of different sizes and scattered pebbles of various types and sizes.



Glaciers spread southward into the Midwest from two centers of ice accumulation in western and eastern Canada.

How did erratics get here?

Many boulders were probably dropped directly from the melting front of the glacier. Others may have been rafted to their present resting places by icebergs in ancient lakes or on floodwaters of some long-vanished stream as it poured from a glacier. Still others, buried in the glacial deposits, could have worked their way up to the land surface as the surrounding

Keep an eye out for erratics. You may find some of these glacial strangers in your neighborhood.

loose soil repeatedly froze and thawed. When the freezing ground expands, pieces of rock tend to be pushed upward, where they are more easily reached by the farmer's plow and also more likely to be exposed by erosion.

Many erratics are of notable size and beauty. Some are used as monuments in courthouse squares and parks, or along highways. Many are marked with metal plaques to indicate an interesting historical spot or event.

Contributed by M.M. Killey

While on a drive through central Illinois, you may catch a glimpse of an erratic (photo by J. Dexter).

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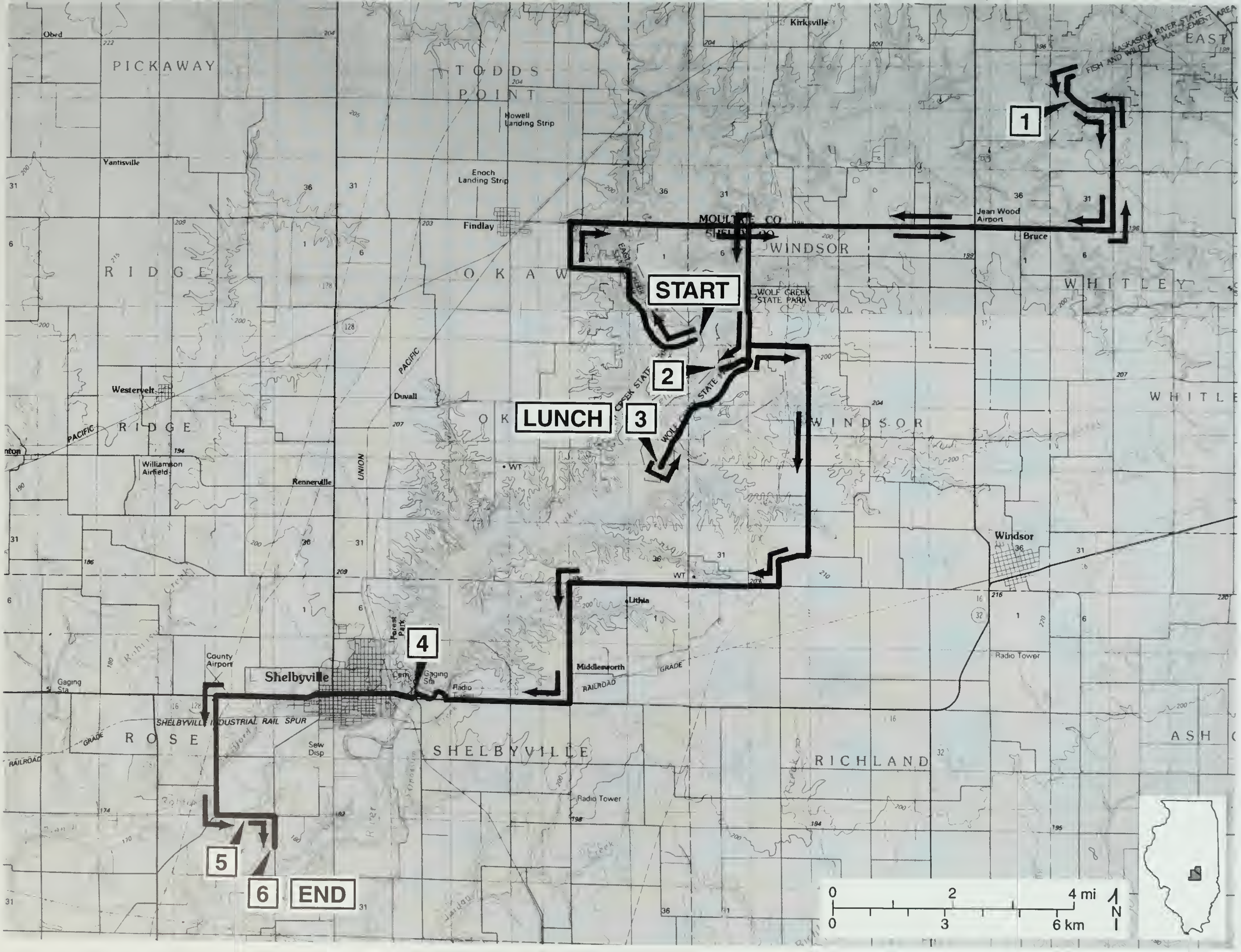

START
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END
PICKAWAY
TODDS POINT
RIDGE
OKAW
WINDSOR
WHITLEY
ROSE
SHELBYVILLE
RICHLAND
ASH
EAST
Shelbyville
Windsor
Findlay
Westervelt
Kirksville
Bruce
Jean Wood Airport
Howell Landing Strip
Enoch Landing Strip
Yantisville
Williamson Airfield
Duvall
Rennerville
Lithia
Middlesworth
County Airport
Forest Park
WOLF CREEK STATE PARK
MOULTRIE CO
SHELBY CO
KASKASKIA RIVER STATE FISH AND WILDLIFE MANAGEMENT AREA
SHELBYVILLE INDUSTRIAL RAIL SPUR
PACIFIC
UNION
RAILROAD
GRADE
Radio Tower
Sew Disp
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3
6 km
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